FHWA-NH-EIS-02-01-F

Final Environmental Impact Statement

Interstate 93 Improvements
Salem to Manchester
IM-IR-93-1(174)0, 10418-C

Volume 1 of 3

April 2004

Federal Highway Administration

New Hampshire Department of Transportation

Interstate 93 Improvements Salem to Manchester IM-IR-93-1(174)0, 10418-C

Salem to Manchester, New Hampshire

Prepared for **New Hampshire Department of Transportation and Federal Highway Administration**

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Bedford, NH

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SALEM – MANCHESTER
IM – IR 93-1(174)0
10418-C
INTERSTATE 93 IMPROVEMENTS
HILLSBOROUGH AND ROCKINGHAM COUNTIES, NEW HAMPSHIRE

FINAL ENVIRONMENTAL IMPACT STATEMENT

Submittal Pursuant to 42 U.S.C. 4332 (2)(c) and
49 U.S.C. 303, 16 U.S.C 470 (f), 33 U.S.C. 1344
by the
US Department of Transportation
Federal Highway Administration
And
New Hampshire Department of Transportation

Cooperating Agencies

US Army Corps of Engineers
US Environmental Protection Agency

4/28/04
Date of Approval

4/28/04
Date of Approval

NH State Historic Preservation Office
NH Department of Environmental Services – Wetlands Bureau

For NH Department of Transportation

For Federal Highway Administration

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The proposed project involves a 19.8-mile segment of Interstate 93 (I-93) from the Massachusetts/New Hampshire state line northward through the Towns of Salem, Windham, Derry, and Londonderry, and ending at the I-93/I-293 interchange in the City of Manchester. The purpose of the project is to increase transportation efficiency within the corridor by reducing congestion and enhancing safety. The Selected* Alternative involves widening I-93 from the existing limited access two-lane highway in each direction to a limited (fully controlled) access four-lane highway in each direction. Five existing interchanges and cross roads within the project corridor will be reconstructed. In addition, three new park-and-ride facilities will be constructed at Exits 2, 3, and 5, bus service and ride-sharing opportunities to Boston and northern Massachusetts will be expanded and enhanced, and space will be reserved in the median to accommodate future commuter light rail trains or other mass transit opportunities. Impacts to the natural, cultural, and socio-economic environment were analyzed, including the secondary impacts associated with the project. Mitigation is proposed to offset or reduce unavoidable direct impacts associated with the project.

* Gray shading throughout the FEIS indicates changes since the DEIS September 2002.

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Executive Summary

A. Project Description and Need

The New Hampshire Department of Transportation (NHDOT) and the Federal Highway Administration (FHWA) have prepared a Draft Environmental Impact Statement (DEIS) for proposed improvements to the Interstate Route 93 (I-93) corridor between Salem and Manchester, New Hampshire. The basic purpose of the I-93 Salem-Manchester project is to improve transportation efficiency and reduce safety problems associated with this approximately 19.8-mile segment of highway from the Massachusetts/New Hampshire state line to Manchester.

I-93 is a north-south principal arterial Interstate highway within the State of New Hampshire and is part of the National System of Interstate and Defense Highways. I-93 in New Hampshire extends a distance of approximately 132 miles from the Massachusetts border at Salem, New Hampshire to the Vermont border at Littleton, New Hampshire. The segment of I-93 under study intersects a number of the important highway routes in southern New Hampshire. Due to population growth, development, and recreational opportunities in New Hampshire, the travel demands for I-93 between Salem and Manchester have exceeded the capacity of this existing four-lane facility for a number of years. Population and traffic projections for the next twenty years support the conclusion that the existing facility will be increasingly less able to function at the levels of service and safety for which it was originally designed. Decreases in the level of service are evident in reduced traveling speeds, increased density of traffic flow, as well as in the traffic backups at some interchanges during commuting hours.

During weekday peak hours, motorists traveling along the I-93 corridor currently experience traffic congestion and substantial delay. The congestion not only results in increased travel times, but also contributes to safety problems, as the limited spacing between vehicles does not afford the motorists sufficient movement to deal with frequent and abrupt lane change maneuvers and sudden stops. Without substantial improvements, or dramatically reduced demand, traffic operations along this section of I-93 are expected to continue to deteriorate under future conditions as traffic volumes increase.

■

Selected Alternative

The NHDOT's Selected Alternative involves a combination of transportation infrastructure improvements and strategies for the 19.8-mile study corridor. The main element of the improvement involves widening I-93 from the existing limited access two-lane highway in each direction to a limited access four-lane highway in each direction. The so-called Four-Lane Selected Alternative (i.e., four lanes in both directions) begins in the Town of Salem, NH at the Massachusetts/New Hampshire State line and extends northerly through Salem, Windham, Derry and Londonderry, and into Manchester, ending at the I-93/I-293 Interchange. In addition, the NHDOT has also selected the following design modifications and infrastructure improvements for the five interchanges and local roads within the project corridor:

- In the Exit 1 Interchange area, the existing Cross Street Bridge will be replaced with a new bridge located just to the north. The existing interchange at Exit 1 will be reconstructed to improve the substandard ramp geometry.

- At Exit 2, the existing interchange will be reconstructed to a diamond-type interchange configuration. Pelham Road will be widened and reconstructed from Policy Road to Stiles Road. Just north of Exit 2, the Brookdale Road bridge will be replaced on-line, utilizing a temporary bridge for maintenance of traffic during construction.

- In the Exit 3 Interchange area, both the northbound and southbound barrels of I-93 are proposed to be relocated (referred to as the Tight Shift Option) into the median area. The interchange ramps will be reconfigured with a diamond interchange design. NH 111 will be reconstructed and widened with the work beginning just west of the NH 111/NH 111A intersection. As NH 111 proceeds to the west, NH 111 is proposed to be relocated (off-line option) north of its existing location before tying into existing NH 111 near the NH 111/Wall Street intersection. NH 111A will be relocated on new alignment west of existing NH 111A.

- In the Exit 4 Interchange area, I-93 will be widened to the east, retaining the existing layout for the southbound ramps. The existing diamond configuration of the northbound ramps will be reconstructed, providing longer ramps. NH 102 will be reconstructed and widened from Londonderry Road to the southbound ramps. The NH 102 bridge over I-93 will be replaced with a new bridge built directly south of the existing bridge. Just north of Exit 4 the Ash Street/ Pillsbury Road bridge will be reconstructed on-line, utilizing a temporary bridge for maintenance of traffic during construction.

- At Exit 5, NH 28 will be widened and reconstructed on-line from Symmes Drive to Liberty Drive including the reconstruction of the Perkins Road and Symmes

Drive approaches, as well as the reconstruction of portions of both Liberty and Independence Drives. The existing diamond interchange will be reconstructed and brought up to current NHDOT standards.

In addition to the highway improvements, three new park-and-ride lots will be constructed with bus service facilities at Exits 2, 3 and 5. The existing park-and-ride lot at Exit 4 will be retained and a new terminal building constructed. Early construction of these facilities and the implementation of additional bus services are proposed as practicable in advance of the highway widening to provide options for commuters seeking alternatives during construction. The current bus service to Boston will be expanded with service from the new park-and-ride facilities and the existing Exit 4 park-and-ride lot, and enhanced ride-sharing opportunities will be implemented to employment centers in northern Massachusetts.

Intelligent Transportation System technologies and Incident Management strategies are an integral part of the overall transportation improvement strategy for the I-93 corridor. The Department proposes to implement measures such as variable message boards, highway advisory radio broadcasts, web site information, emergency reference markers, and coordination strategies among safety agencies before the highway widening. Additional measures will be added as part of the highway widening construction.

The Selected Four-Lane Alternative will accommodate space for a potential future rail corridor between the MA/NH state line northerly to the Exit 5 Interchange. The potential light rail line within the highway corridor could be a link in a future rail system providing rail service between Lawrence, MA or Woburn, MA (and ultimately Boston, MA) to the south and the Manchester Airport and/or the City of Manchester, NH to the north. The proposed project layout will not include rail service within the I-93 corridor, or along the former Manchester and Lawrence Rail Line Corridor. NHDOT in concert with the Commonwealth of Massachusetts will be initiating a transit study from Boston, MA to Manchester, NH as a first step to planning long term rail and bus investments to service the region served by I-93.

The total estimated cost of the Selected Alternative, including mitigation, is $421.4 million.

B. Project History

The Interstate System in New Hampshire was built in the 1960's and early 1970's. The 19.8-mile section of I-93 between Salem and Manchester has not been substantially reconstructed or widened since it was first constructed in the early 1960's.

The New Hampshire Legislature formally recognized the need to widen this section of I-93 and included the project in the first State Ten-Year Highway Plan, when that plan was enacted into legislation in 1986. In 1988, the NHDOT initiated the development of conceptual widening alternatives for the southerly section of the I-93 corridor in the Town of Salem. At that time, the idea was to systematically reconstruct and widen the 19.8-mile section of I-93 by proceeding from south to north over a period of years with completion by the year 2001–2002. As the process moved forward public meetings were held in 1989 in the Town of Salem for public comment on the preliminary improvement concepts. As the NHDOT proceeded, the environmental resource agencies registered their concerns relative to the NHDOT's segmented approach and strongly suggested that an in-depth corridor wide environmental study that considers all alternatives should be conducted to gain environmental approvals.

In 1991, the FHWA and NHDOT initiated preliminary designs and environmental analysis of alternatives and impacts within the framework of an Environmental Impact Statement (EIS).

As the EIS moved forward in 1992, questions were raised as to the NHDOT's methodology for projecting future traffic volumes on I-93 and how any proposed highway improvements to I-93 would interface with the rest of the intermodal transportation network in New Hampshire. In response, the NHDOT agreed in 1993 to develop a Statewide Transportation Model that would provide a more effective methodology for projecting future traffic volumes and for considering the interplay between highway improvements and traffic.

In 1999, with the development of the traffic model nearing completion, the Department restarted the EIS process by initiating preliminary engineering and environmental studies.

In 2000, the NH State Legislature via House Bill (HB) 1106 identified I-93 as a high priority project, because of the importance of this highway corridor to the region and the State. Restarting the EIS process began with the development of a public participation program including the creation of an Advisory Task Force (ATF) in March 2000 to assist the NHDOT in identifying issues and possible solutions regarding the project's purpose and need. In addition, the tenets of environmental streamlining as outlined in the TEA-21 federal legislation were followed in an effort to streamline the environmental permitting process, so that improvements could be constructed and implemented as soon as possible.

As an outgrowth of the streamlining process and in conjunction with the public participation program, the Resource Agency meetings for this project, normally held at NHDOT headquarters in Concord, were held in the communities along the project corridor. Information related to the study was presented and distributed at these meetings. The meetings were open to the general public and public participation was encouraged through public notice. Additional meetings were also held with the Resource Agencies as part of the streamlining process and to receive guidance and

feedback on issues related to the development of the DEIS. These meetings resulted in additional studies or analysis, as appropriate, to address comments received from these agencies.

In September of 2002, the DEIS was published and made available to project stakeholders via direct mailings and to the general public through a project website. After circulation of the DEIS, a Public Hearing was held on November 12 and November 14, 2002, at the Salem High School and at the McLaughlin Middle School in Manchester, respectively. Comments on the Preferred Alternative (as identified in the DEIS), the DEIS itself, and related issues were received at the Hearing. A summary of the Hearing comments is contained in Volume 3 of this document and in the Report of the Commissioner included in Appendix I.

Subsequent to the Public Hearing, there has been on-going coordination with State and Federal resource agencies to address project issues. In June of 2003, in a letter of agreement on project issues (included in Appendix J) to New Hampshire's Governor Benson; the NHDOT, the New Hampshire Department of Environmental Services (NHDES) and the New Hampshire Fish and Game Department (NHF&GD) jointly recognized the importance and need of the project, indicated satisfaction with the size and emphasis of the project mitigation package, and pledged a collaborative effort to resolve issues of concern and to expedite the design and construction of this project.

In August of 2003, after review of the revised and expanded project mitigation package, USEPA indicated that they did not intend to veto the project based on the proposed mitigation (see letter included in Appendix J). In a letter dated December 30, 2003 (included in Appendix J), USACOE confirmed the Selected Four-Lane Alternative as the Least Environmentally Damaging Practical Alternative (LEDPA) and that the minimization measures and proposed mitigation are appropriate to the scope and degree of proposed impacts and meet requirements of the 404(b)(1) Guidelines necessary for permitting the project.

C. Alternatives Evaluated

Based on the analysis of a number of multimodal and highway improvement alternatives, the following seven alternatives or combinations thereof were selected as a "reasonable range of alternatives" for more detailed evaluation in this EIS:

1. The No-Build Alternative, which essentially serves as the baseline condition for comparison with the Build Alternatives.

2. Transportation Systems Management (TSM) measures, specifically minor improvements such as ramp lengthening and lane widenings, that can be accomplished within the existing ROW at minimal expense. Such measures

generally do not address the long-term project purpose and need, but will help to alleviate problems in the near term. Two other TSM measures, ramp metering and shoulder lane use, were determined to be impractical and were not proposed for further consideration.

3. Widening I-93 to 4-lanes in each direction for the entire length of the corridor including interchange improvements, in addition to constructing or expanding park-and-ride lots at Exits 2, 3, 4, and 5, and providing room and, as practical, constructing sub-grade for future rail transit service within the highway corridor. This is the Selected Alternative.

4. Widening I-93 to 3-lanes in each direction for the entire length of the corridor including interchange improvements, in addition to the same park-and-ride lot construction and provision for future rail transit service as noted with the 4-lane widening alternative.

5. Widening I-93 to 4-lanes in each direction south of Exit 3 and 3-lanes in each direction north of Exit 3 including interchange improvements, along with the provisions proposed with either the 3 or 4-lane widening schemes. This is the so-called "Combination Alternative".

6. Transportation Demand Management (TDM) measures, specifically Intelligent Transportation Systems (ITS) techniques as well as employer-based measures utilizing incentives and disincentives to encourage people to not drive alone. It was concluded that congestion pricing, another TDM measure, would be impracticable.

7. Improvements in bus service to include expanding existing service and providing an enhanced service to employment centers in northern Massachusetts. After ridership studies, it was concluded that neither rail service nor HOV lanes would be effective alone or in combination with other mode options in satisfying the need for the project.

D. Summary of Beneficial and Adverse Impacts

Impacts associated with all the alternatives that were considered are summarized in **Figures 2.6-1 and 2.6-2**. Impacts of the Selected Alternative including transportation improvements and costs are summarized in **Figure 2.7-23**. Relative to air quality, construction of the Selected Alternative will not lead to any exceedance of State or Federal Carbon Monoxide (CO) standards. From a mesoscale level, the project will be in compliance with both the 1990 Clean Air Act Amendment and the New Hampshire State Implementation Plan.

From a water quality standpoint, pollutant loading will increase slightly in four streams, but be lower or show no net increase in 17 of 21 streams crossed by the Selected Alternative, because of the proposed stormwater-treatment measures. These measures include grassed swales and detention basins throughout the length of the project corridor. The Tight Shift Option at Exit 3 is expected to improve the quality of stormwater runoff eventually reaching Canobie Lake (Salem's municipal water supply). Water Quality will be improved by moving the highway away from Canobie Lake and by moving the northbound on and off-ramps out of the watershed. Potential impact to surface waters due to road salt application continues to be an issue of a regional nature. NHDOT will continue to monitor chloride levels in selected streams in cooperation with NHDES and USEPA. From a groundwater recharge standpoint, about 82 acres of stratified drift aquifer will be unavoidably covered with new, impervious roadway surface (including the Exit 5 park-and-ride lot). In addition, widening the highway will require that culverts be lengthened at many of the 23 stream crossings, resulting in some loss of aquatic habitat, including one additional perennial stream affected by the park-and-ride facility at Exit 5.

The Selected Alternative will impact an estimated 6 acre-feet of floodway and 43 acre-feet of 100-year floodplain. The largest impacts occur to the floodplains lying along Policy Brook, Porcupine Brook, Harris Brook, and Beaver Brook. Mitigation has included steepening of highway embankments and utilizing retaining walls where appropriate. Additional mitigation will include providing flood storage in the form of specially-designed flood storage basins, stormwater extended-detention basins, and newly created wetlands in locations adjacent to or upstream of flood-prone areas.

Because the majority of the highway widening and other improvements will take place within the existing right-of-way, only about 10 acres of important farmland soils will be converted under the Selected Alternative. Approximately 40 percent of this conversion involves prime farmland soil, while the remainder is statewide or locally important farmland soils. About one acre of currently active farmland will be affected by the Selected Alternative, primarily at Exit 1.

The Selected Alternative will impact approximately 77 acres of wetlands including impacts associated with the proposed park-and-ride lots. The majority (64 percent) of this impact occurs to forested wetland, the most common type along the highway corridor. In addition, three vernal pools, which function as essential breeding habitat for mole salamanders and wood frogs, will be impacted by the filling associated with the highway widening. The sum total of all habitat loss, i.e., both wetlands and uplands, is estimated to be about 260 acres with the Selected Alternative, which includes the three proposed park-and-ride lots. The proposed project mitigation and enhancement package, consisting of about 26 -34 acres of wetland creation and approximately 1000 acres of land preservation, will offset this loss. Only one known location of a state-threatened or endangered plant species, the wild lupine (*Lupinus perennis*), will be affected by the Selected Alternative. Attempts will be made to relocate colonies of this species as mitigation. Although the state threatened and endangered hognose snake

(*Heterodon platyrhinos*) has been reported within the vicinity of the corridor, no known locations will be affected by the project. The US Fish and Wildlife Service also requested that a study be conducted to determine whether the New England cottontail (*Sylvilagus transitionalis*), a candidate species for federal protection, is present in the project corridor. A field investigation conducted during the winter of 2002-2003 failed to find any evidence of this species in habitats along the corridor and the Selected Alternative is not expected to have any effect on the species.

The Selected Alternative will result in elevated noise levels at certain receptor locations along the project corridor. In the year 2020, 51 more receptors will experience noise levels that approach or exceed the FHWA's Noise Abatement Criteria as compared to current conditions (i.e., 316 versus 265 receptors, mostly homes). Sound walls have been proposed to mitigate these sound impacts wherever practicable from a cost and effectiveness standpoint. Construction of approximately 27,700 linear feet of soundwalls at 11 locations are proposed. Visual impacts of the Selected Alternative will be largely limited to highway profile elevation changes, especially at Exit 3 and sound walls at 11 locations along the corridor. From an abutter perspective, sound walls serve a dual purpose of reducing both noise and visual impacts. The reduction of the median width and reduction of the natural vegetation buffer between the highway and adjacent development will also have some negative effect on aesthetics.

From a cultural resources standpoint, the Selected Alternative affects 23 archaeological sites, 11 of which are Native American and 12 are historic archaeological resources. The Selected Alternative will also affect six extant historic structures and properties, which have been determined to be eligible for the National Register of Historic Places (i.e., Kinzler House, Robert Armstrong House, George Armstrong House, Robert J. Prowse Memorial Bridge, Reed Paige Clark Homestead, and Gearty House). There will be adverse effects to the Robert Armstrong House, George Armstrong House, Robert J. Prowse Memorial Bridge, and the Gearty House.

Widening and interchange improvements associated with the Selected Alternative will require the acquisition of 21 residential and 14 business structures, including 8 residential and 3 business structures associated with the new park-and-ride lots. NHDOT conceptual relocation studies indicate that alternative housing and business sites are available for residential and business relocations. The effect on the tax bases of the acquisitions is not substantial and amounts to a loss of approximately $11.0 million out of a total of $7.1 billion in assessed value for the five communities. This results in a total reduction of about $.20 million in local tax revenues or less than 0.1 percent for the five communities. There will be no environmental justice impacts as no minority or low-income populations are differentially affected by the project. In addition, no community facilities (e.g., schools, fire stations, town buildings, public parks, etc.) will be affected. Secondary growth impacts in the I-93 region may involve an increase in population of nearly 41,000 people and an increase in employment opportunities amounting to almost 22,000 additional jobs by the Year 2020. These increases are in addition to what might be expected if the highway is not improved.

An estimated 13 sites with potential hazardous material involvement will be affected by the project. These sites will require further study, although none is expected to pose a substantial problem.

From an energy standpoint, the Selected Alternative will create a more efficient flow of traffic resulting in future fuel conservation as compared to the No Build. The widening and other improvements will require a higher expenditure of energy for various maintenance activities like plowing, sanding, roadway surface and bridge repairs, as compared to current conditions.

E. Issues and Areas of Controversy

The primary issues throughout the EIS process have been the consideration of instituting rail service in the region served by I-93 and the extent of secondary growth that may occur in addition to what might be expected if the highway were not improved.

Consideration of rail service was evaluated as part of the analysis of a broad range of alternatives that might address the project purpose and need. It was found that rail service, if implemented, would not sufficiently reduce demand along the highway to preclude the need to widen I-93 from Salem to Manchester.

Relative to secondary growth, a panel of "experts" in the fields of land use, economics, environment, etc. was established and the Delphi approach was utilized to shed light on the issue. The question of whether mitigation should be provided to offset the effects of the secondary growth, and if so, to what degree and where has also been an issue. Secondary impacts are difficult to predict with any certainty and are speculative by their nature. Under current NHDOT and FHWA practices, impacts associated with secondary growth that might result from highway improvement projects are typically not mitigated, as mitigation for such possible future development would be the responsibility of the proponent of the development. NHDOT and FHWA do not believe that such mitigation is the responsibility of the public. Since development issues have traditionally been addressed by local municipalities, an initiative is proposed as an enhancement to this project to provide technical assistance in order to help the communities potentially affected by I-93 widening cope with future growth. This proposed technical assistance is complimentary to and builds upon the effects of other state initiatives on Sprawl and Smart Growth. Further, the proposed project mitigation package to compensate for direct impacts to wetlands, floodplains, and other natural resources will result in providing and protecting open space, and in doing so provide a substantial measure of relief relative to future development.

At the local level, a number of issues of concern were also expressed. The amount of wetland impact and the best approach for providing compensatory mitigation was

an issue throughout the project's development. See **Figure 4.6-2** for the locations of potential mitigation sites that were considered. Representatives of the Town of Salem, also voiced concern relative to project impacts on floodplains and whether the project would exacerbate existing flooding problems in the town. In addition, potential impact on water quality in the major water bodies of Canobie Lake and Cobbetts Pond was an issue. The issue of noise impacts, including the need for sound walls, was a concern to a number of property owners immediately adjacent to the highway. Direct impacts to properties were also a concern throughout the corridor.

The application of road salt and the potential impact to streams and other waterbodies along the project corridor were also raised as issues after publication of the DEIS. An extensive stream sampling study was conducted during the winter of 2002/03 to determine baseline levels of chlorides during the months when road salt is applied to I-93 and secondary roadways. Concurrent sampling conducted jointly by NHDES and USEPA, using dataloggers placed in selected streams, also revealed that chloride levels, in some streams, exceeded the chronic aquatic life criterion for surface waters. The sampling indicated that chloride levels were elevated upstream of the influence of I-93 indicating that it is a regional issue. Additional water quality sampling for chloride is being conducted jointly by NHDOT, NHDES and USEPA over the 2003/04 winter to provide additional regional baseline data.

F. Other Governmental Actions

The NHDOT and FHWA are not aware of any additional federal actions or any state or local government actions within the project study area that would conflict with the proposed action.

G. Major Unresolved Issues

The one major unresolved issue identified since publication of the DEIS relates to the application of road salt and the potential impairment of surface waters due to elevated chloride concentrations. Baseline water quality monitoring data were collected during the winter of 2002/03 in more than 17 streams throughout the project corridor. Several streams exhibited chloride level spikes above the established water quality criteria during at least one snow melt/precipitation event. Within two streams, Policy Brook and the north tributary to Canobie Lake, the observed chloride concentrations, on more than one occasion, exceeded the chronic aquatic life criterion of 230 mg/l, as adopted in the NHDES Surface Water Quality Regulations. In most cases, the contribution from I-93 toward these elevated levels is minor compared to the background levels in the streams from other sources upstream of the influence of the I-93 roadway area. In Policy Brook, for example, the elevated chloride concentrations were observed both upstream and downstream of the I-93 roadway indicating that this is a regional issue and not due specifically to

road salt applications on the I-93 roadway. In addition, the use of potassium chloride in the water softening treatment process in a nearby public supply well is suspected to contribute to the elevated chloride concentrations in the north tributary to Canobie Lake.

The overall issue of elevated chloride levels in the study area is still being defined. NHDOT is collaborating with NHDES and USEPA to collect additional water quality monitoring data to better assess the extent and magnitude of the elevated chloride levels on a more regional basis. NHDES has indicated on a preliminary basis that the development of a Total Maximum Daily Load (TMDL) for chloride may be the best course of action to address the issue on a regional basis and minimize the potential impairment of the affected streams. NHDOT will continue to participate in the data collection efforts as part of any TMDL development process and will continue to improve its efficiency in road salt usage, as well as conduct outreach efforts to help local public works officials improve their ability to minimize the use of road salt and improve storage practices.

H. Federal and State Actions Required for the Implementation of Proposed Action

- An Individual Wetland Permit application has been submitted jointly to the US Army Corps of Engineers (USACOE) and New Hampshire Department of Environmental Services (NHDES) for their approval. This project's development has followed the USACOE's Highway Methodology, which is designed to integrate the Section 404 permitting process with the requirements of the National Environmental Policy Act (NEPA).

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- A Section 401 Water Quality Certificate is required from NHDES before the Section 404 permit can be issued.

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- Pursuant to the National Pollution Discharge Elimination System (NPDES), a Notice of Intent (NOI) application to the USEPA for a General Permit for Construction Activity is required before construction can begin. A Stormwater Pollution Prevention Plan consistent with NHDOT Standard Specifications, which incorporate Best Management Practices (BMPs) for minimizing soil erosion and sediment movement, will be developed and submitted with this application.

- A variance from the NH Comprehensive Shoreland Protection Act may be required from NHDES for impacts on, or near, the banks of the two fourth-order or higher streams in the project area: Cohas Brook and Spicket River.

- Concurrence by the National Marine Fisheries (NMS) that the Selected Alternative will have an "adverse effect" that is "not substantial" on Essential Fish Habitat (EFH) for Atlantic Salmon is required.

- A Record of Decision (ROD) issued by FHWA is required before this project can proceed to final design. The ROD is issued no sooner than 30 days after release of the Final EIS.

1 Introduction

1.1 General Overview

The New Hampshire Department of Transportation (NHDOT) and the Federal Highway Administration (FHWA) have prepared an Environmental Impact Statement (EIS) for proposed improvements to the Interstate Route 93 (I-93) corridor between Salem and Manchester, New Hampshire. The basic purpose of the I-93 Salem-Manchester project is to improve transportation efficiency and reduce safety problems associated with this approximately 19.8-mile segment of highway from the Massachusetts/New Hampshire state line to Manchester.

This Final Environmental Impact Statement (FEIS) documents Phase V of the NHDOT's EIS study process and includes three volumes. Volume 1 contains all text and tables, Volume 2 contains all figures, and Volume 3 contains responses to comments on the Draft EIS (DEIS) received through the Public Hearing process as well as all Appendices. The first chapter of the FEIS describes the project study area and project history, and provides a description of the overall purpose and need for the project. Chapter 2 describes the transportation improvement strategies and other alternatives that were originally considered and that led to the identification of a reasonable range of alternatives for detailed study. Chapter 3 describes the existing baseline conditions in the study area, while Chapter 4 identifies the environmental consequences of alternatives studied in detail. Chapter 5 describes the Section 4(f) evaluation process and potential FHWA actions that would require review under Section 4(f), and discusses potential avoidance and mitigation measures. Chapters 6 and 7 provide a list of EIS preparers and a document distribution list, respectively. Chapter 8 describes the agency coordination and public participation that has taken place to date, while references cited can be found in Chapter 9. Chapter 10 gives the reader a subject index and an acronyms list. Chapter 11 identifies project commitments made by NHDOT and FHWA to mitigate effects of the Selected Alternative.

This FEIS has been prepared in conformance with the requirements of the Council on Environmental Quality (CEQ), and National Environmental Policy Act (NEPA) regulations and associated guidance documents of the FHWA. The purpose of an EIS is to provide full disclosure of potentially significant environmental impacts, and to inform decision-makers and the public of the reasonable alternatives, which would avoid or minimize adverse impacts. The EIS describes existing transportation, social,

economic, cultural and environmental resources in the study area and discusses the potential effects of the various project alternatives on these resources.

1.2 Project History and Status

The Interstate System in New Hampshire was built in the 1960's and early 1970's. The 19.8-mile section of I-93 between Salem and Manchester has not been substantially reconstructed or widened since it was first constructed in the early 1960's.

The New Hampshire Legislature formally recognized the need to widen this section of I-93 and included the project in the first State Ten-Year Highway Plan, when that plan was enacted into legislation in 1986. In 1988, NHDOT initiated the development of conceptual widening alternatives for the southerly section of the I-93 corridor in the Town of Salem. At that time, the idea was to systematically reconstruct and widen the 19.8-mile section of I-93 by proceeding from south to north over a period of years with completion by the year 2001–2002. As the process moved forward public meetings were held in 1989 in the Town of Salem for public comment on the preliminary improvement concepts. As the NHDOT proceeded, the environmental resource agencies registered their concerns relative to the NHDOT's segmented approach and strongly suggested that an in-depth corridor-wide environmental study, that considered all alternatives, would be necessary to gain environmental approvals.

In 1991, the FHWA and NHDOT initiated preliminary designs and environmental evaluations of alternatives and impacts within the framework of an EIS.

As the EIS moved forward in 1992, questions were raised as to the NHDOT's methodology for projecting future traffic volumes on I-93 and how any proposed highway improvements to I-93 would interface with the rest of the intermodal transportation network in New Hampshire. In response, the NHDOT agreed in 1993 to develop a Statewide Transportation Model, which would provide a more effective methodology for projecting future traffic volumes and for considering the interplay between highway improvements and traffic.

In 1999, with the development of the traffic model nearing completion, NHDOT restarted the EIS process by initiating preliminary engineering and environmental studies.

In 2000, the NH State Legislature via House Bill (HB) 1106 identified I-93 as a high priority project, because of the importance of this highway corridor to the region and the State. Restarting the EIS process began with the development of a public participation program including the creation of a local Advisory Task Force (ATF) in March 2000 to assist the NHDOT in identifying issues and possible solutions regarding the project's purpose and need. In addition, the tenets of environmental streamlining as outlined in the TEA-21 Federal legislation were followed in an effort

to streamline the environmental permitting process, so that improvements could be constructed and implemented as soon as possible. In the spirit and intent of this environmental streamlining, the five Federal and three State agencies participating in the review of this project signed off on the basic project purpose and need in January, 2001, and the reasonable range of alternatives to be studied in September 2001 (see Appendix A).

As an outgrowth of the streamlining process and in conjunction with the public participation program, the Resource Agency[1] meetings for this project, normally held at NHDOT headquarters in Concord, were held in the communities along the project corridor. Information related to the study was presented and distributed at these meetings. The meetings were open to the general public and public participation was encouraged through public notice. Additional meetings were also held with the Resource Agencies as part of the streamlining process and to receive guidance and feedback on issues related to the development of the EIS. These meetings resulted in additional studies or analysis, as appropriate, to address comments received from these agencies.

In September of 2002, the DEIS was published and made available to project stakeholders via direct mailings and to the general public via a project website. Concurrent with the publication of the DEIS, a Section 404 wetland permit application was submitted to US Army Corps of Engineers (USACOE) and a State wetlands permit application was submitted to the NH Department of Environmental Services (NHDES). After circulation of the DEIS, a formal Public Hearing was held over two evenings on November 12 and November 14, 2002, at the Salem High School and at the McLaughlin Middle School in Manchester, respectively. The Public Hearing was held jointly with the USACOE and the NHDES. Comments on the Preferred Alternative (as identified in the DEIS), the DEIS itself, and related issues were received at the Hearing. A summary of the hearing comments is contained in Volume 3 and in the Report of the Commissioner included in Appendix I. Further comments received through the Public Hearing with respect to the DEIS along with responses are contained in Volume 3.

Subsequent to the Public Hearing, there has been ongoing coordination with State and Federal resource agencies to address project issues. In June of 2003, in a letter of agreement on major issues of concern (included in Appendix J) to New Hampshire Governor Benson; the NHDOT, NHDES, and the New Hampshire Fish and Game Department (NHF&GD) jointly recognized the importance and need of the project, indicated satisfaction with the size and emphasis of the project mitigation and enhancement package, and pledged a collaborative effort to resolve issues of concern and to expedite the design and construction of this project.

[1] See Section 2.4.1 for a list of the environmental and cultural Resource Agencies.

In August of 2003, after review of the revised and expanded project mitigation package, USEPA indicated that they did not intend to veto the project based on the proposed mitigation (see letter included in Appendix J). In a letter dated December 30, 2003 (included in Appendix J), USACOE confirmed the Selected Four-Lane Alternative as the Least Environmentally Damaging Practical Alternative (LEDPA) and that the minimization measures and proposed mitigation are appropriate to the scope and degree of proposed impacts and meet requirements of the 404(b)(1) Guidelines necessary for permitting the project.

1.3 General Description of Project Area

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1.3.1 Study Area

The segment of I-93 under study is located in south-central New Hampshire (**Figure 1.3-1**). This segment is located within the five communities of Salem, Windham, Derry and Londonderry in Rockingham County, and Manchester in Hillsborough County. It is this segment of I-93 and the adjoining land area, through which this segment passes, that comprise the primary I-93 study area.

The study area is generally located in the Seaboard Lowland[2] section of New England, and is characterized by low rolling hills rising 100 to 300 feet above the intervening stream valleys. The present landscape character is largely the result of glaciation. Important natural features include a number of lakes and major stream systems; in particular, Canobie Lake, Cobbetts Pond, Spicket River and tributaries, Beaver Brook and tributaries, and Cohas Brook and tributaries.

The section of I-93 being studied is approximately 19.8 miles long extending from the Massachusetts border in Salem to the junction of I-93 with I-293 in Manchester (**Figure 1.3-1**). I-93 is a limited (fully controlled) access highway originally constructed in the early 1960's. At present, it consists of four lanes (two lanes northbound, two lanes southbound). The north and southbound barrels follow independent vertical profiles. There are five interchanges (Exits 1-5) along this section of I-93. The roadway right-of-way generally varies from about 150 to 500 feet in width and both barrels are on independent profiles. The median width (distance between lanes of opposing direction) is typically 70 feet or more, although as it approaches the state line it is as narrow as 30 feet. Near Exit 3, the northbound and southbound lanes diverge so that the lanes are separated by over 1,200 feet.

The I-93 highway within the study area is fed by a network of state and local roadways. Major east-west roads include NH 101 and I-293, NH 102, NH 111,

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[2] See Fenneman, 1938.

NH 111A, NH 97, and NH 38. Major north-south roads in proximity to I-93 include NH 28, NH 28 Bypass, and NH 128.

Also within the study area are two railroad corridors. Although these rail corridors lie outside the primary study area and do not currently provide passenger service, they merit consideration when assessing the current and future transportation needs of the region serviced by I-93. As elements of the transportation network, these rail corridors have the potential for addressing demand on the I-93 corridor. Both rail corridors were once part of the former Boston and Maine Railroad system **(Figure 1.3-1)**. The East Rail Corridor extends from Manchester southerly through Londonderry, Derry, Windham, and Salem to Lawrence, Massachusetts. This 28-mile rail corridor, located on the former B&M Manchester and Lawrence Branch, essentially parallels the I-93 highway corridor within the study area. The West Rail Corridor extends from Manchester through Bedford, Merrimack, and Nashua to Lowell, Massachusetts. This rail corridor, located on the former B&M New Hampshire Main Line, runs along the west side of the Merrimack River parallel to the F.E. Everett Turnpike throughout its 30-mile length. In Bedford, the rail line crosses the Merrimack River to access downtown Manchester.

For purposes of inventorying environmental resources which might be directly impacted as a result of improving the existing highway, the primary study area is generally defined as a band 500 feet east and west of the northbound and southbound lanes, and is a minimum of 1,000 feet wide, with additional width where the I-93 northbound and southbound barrels diverge. Because of the potential impacts on resources, the existing infrastructure investment, and the cost associated with new freeway construction, relocation of the existing highway outside the existing 1,000-foot corridor limit is not a consideration. The study area in the vicinity of each of the five interchange areas extends to each side of the existing I-93 right-of-way approximately 2,000 feet along the connecting roadways. The width along the connecting roadways is approximately 1,000 feet.

The north/south study area limits are based on political geographical boundaries (NH/MA state line) and previously completed improvements at the interchange of I-93 and I-293/NH 101 constructed in the early 1990's. These boundaries mark the extent of potential direct impact to environmental resources. They do not however limit the evaluation of Traffic Demand Management (TDM) measures and mass transit alternatives, which may logically have to extend further to the north or south.

For the purpose of considering the sphere of influence of I-93, the regional context of the highway was examined using data from Origin and Destination profiles collected for the project in 1992, and reaffirmed with new data collected in October and November of 2001. The total number of responses by town of origin were grouped according to order of magnitude (0 to 1 trip origins per town, 1 to 10 origins, 10 to 125, and 125 to 1,000 or more) and then plotted and graphically shaded on the map (**Figure 1.3-2**), with darker shading indicating higher numbers of trip origins. This confirms that the communities immediately adjacent to I-93 exhibit the highest propensity to serve as origins for I-93 user trips, and thus are the most directly

dependent on, and affected by, the highway. The results are illustrated graphically by the two denser shaded areas on **Figure 1.3-2**. The Origin and Destination profiles serve as a starting point for considering the area over which improvements to the highway's capacity could result in secondary impacts.

While the highway draws traffic from beyond the immediate communities through which it passes, the relative number of trip origins per unit area is more diffused the further the distance from the highway.

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1.3.2 Existing Roadway System

I-93 is a major link in the Interstate System as well as the National Defense Highway System. It extends from Boston, Massachusetts to St. Johnsbury, Vermont, just north of the New Hampshire/Vermont border. It is a principal arterial interstate highway and serves as an important transportation corridor between the greater Boston metropolitan area and the communities in south-central New Hampshire. It also provides access to the recreational areas of northern New Hampshire. The corridor is a limited access (i.e., no access between the highway and abutting private property) freeway with access along the study area segment available only from the five interchanges spaced along the corridor.

Interstate 93 (I-93), as originally constructed in the early 1960's, was expected to carry 20,000 vehicles per day within its design life of 20 years. In 1997, traffic volumes were recorded in Salem (south of Exit 1) in excess of 100,000 vehicles per day, with the segments to the north carrying between 60,000 and 80,000 vehicles per day. Operating conditions, during the peak hours of the day, are currently poor with the segments of the corridor south of Exit 4 operating at level of service (LOS[3]) E or F. Each of the interchanges also exhibits poor levels of service. Exit 4 was reconstructed in 1990 in part to eliminate the poor weave condition at the southbound ramps and the recurring hazard associated with exiting northbound traffic backing up onto I-93. Exit 3 and Exit 5 experience similar backups and congestion problems, and Exit 2 also warrants major renovations to provide safe and efficient access to the highway. Lastly, the geometry of the southbound off ramp at Exit 1 is substandard, and in need of realignment.

Since the construction of the I-93 segment under study in the 1960's, there have been a number of major projects along the I-93 corridor (e.g., involving bridges, rest areas, weigh stations). Three projects directly involving safety and traffic operational improvements have been completed: the widening of the northbound barrel at Exit 1

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[3] Level of service is a qualitative measure used to describe the operational conditions within a traffic stream and the perception of quality of traffic flow by a motorist or passenger. Level of service (LOS) generally describes these conditions in terms of such factors as speed and travel time, density or freedom to maneuver, traffic interruptions, comfort and convenience, and safety and, in so doing, provides an index to quality of traffic flow. Six levels of service are defined ranging from LOS A, representing the best operating condition to LOS F, the worst. See 2000 Highway Capacity Manual, Special Report 209 Transportation Research Board, Washington,D.C. for additional details.

required to provide safe access to the Rockingham Mall in Salem (1990), the previously mentioned reconstruction of the Exit 4 interchange to provide safe and efficient movement between I-93 and NH 102 (1990), and the addition of new guard rail and rumble strips along the entire 19.8-mile segment (2000).

The Salem rest area off the northbound barrel was reconstructed in 1993. The northbound and southbound weigh stations along I-93 in Windham were replaced in 2000. Improvements to I-293 (from the Merrimack River to the west) and the I-293/ NH 101/I-93 interchange area to the east are currently under reconstruction that began in 2001. In addition, several bridges carrying I-93 over local roadways and waterways have been reconstructed or replaced. All of these bridges, prior to construction, were deficient relative to structural condition. Construction has been ongoing since 1994. The condition of these bridges reflects, to a degree, the condition of the highway. After more than 30 years of service, the highway is showing signs of serious deterioration.

These bridges include:

- Northbound bridge over NH 111A in Windham (replaced in 1994),
- Northbound (replaced in 1994) and southbound (replaced in 1996) bridges over Bridge Street (North Lowell Road) in Windham,
- Northbound and southbound bridges over Fordway Extension in Derry (widened and rehabilitated in 1996),
- Northbound and southbound bridges over Kendall Pond Road in Derry (widened and rehabilitated in 1996),
- Northbound (replaced in 1995) and southbound (replaced in 1994) bridges over Stonehenge Road in Londonderry,
- Northbound bridge over Cohas Brook in Manchester (widened and rehabilitated in 2002),
- Northbound and southbound bridges over Bodwell Road in Manchester (widened and rehabilitated in 2002), and
- Southbound bridge over the I-293 westbound ramp in Manchester (widened and rehabilitated in 2002).

At present, there are several other highway projects affecting I-93 either under study or that will be under study in the next year, under design, or have been recently implemented. A section of NH 111 in Windham and Salem is currently under construction. The improvements are proposed in an effort to enhance safety and relieve traffic congestion along NH 111 from the I-93/Exit 3 interchange in Windham easterly to the previously improved segment of NH 111 in Salem. The Towns of

Derry and Londonderry are currently in the preliminary design/environmental evaluation process to consider alternatives and propose construction for a new interchange on I-93 to be located between Exits 4 and 5, locally referred to as "Exit 4A." The current schedule estimates completing the Final EIS in 2005 and beginning construction (assuming funding is available) in 2008.

A paving project to inlay sections of deteriorating pavement on I-93 between Salem and Manchester is being planned for construction in 2004. This project is needed to address pavement deficiencies and maintain serviceability in the interim until the I-93 full reconstruction can begin.

A fourth project involves constructing a highway corridor to provide access between the F. E. Everett Turnpike and the Manchester Airport. The Proposed Action for the proposed airport access highway allows for improved transportation service to the airport and to the surrounding industrial area from the F. E. Everett Turnpike. Construction is expected to begin in 2005 with completion anticipated in 2008. As proposed, these improvements do not include a direct connection to I-93, as was considered early in the Manchester Airport Access Road Project.

A fifth project, accomplished in the summer of 2002, included the installation of Emergency Reference Markers and signs along I-93 from the New Hampshire/ Massachusetts state line in Salem to the I-93/I-293 split in Manchester to help improve emergency response times and increase safety. This test program is part of an overall incident management plan for the I-93 corridor. The reference markers will provide direction, route, and mile location of travel information to assist motorists in identifying their location when reporting an incident.

In addition to the installation of the Emergency Reference Markers and signs, the NHDOT will initiate an evaluation of Intelligent Transportation System strategies, beginning in 2004, for use in managing traffic and incidents more efficiently and improving safety before, during, and after the widening of I-93.

Currently, NHDOT is developing final design plans and contract documents for the early construction of new park-and-ride lots and bus transit facilities (see Section 2.3.5.4) at Exit 2 in Salem and Exit 5 in Londonderry. It is anticipated that these facilities will be constructed in 2005. See **Figures 2.3-38 and 2.3-41**.

In April 2002, the NHDOT in a cooperative effort with the Massachusetts Executive Office of Transportation and Construction (MEOTC), the Merrimack Valley Regional Transit Authority, and The Junction Transportation Management Organization (TMO), implemented express bus service for New Hampshire employees working at Wyeth BioPharma in Andover, Massachusetts. The pilot project was developed to improve air quality, help in reducing traffic on I-93 and the local roadways, and provide alternative commuting options.

NHDOT has also completed a Bikeway Feasibility Study (March 2003) to identify alternative transportation corridors for pedestrian and bicycle travel between Salem and Manchester. In the area between Salem and Manchester, the study recommended the development of a rail facility located along the abandoned Manchester-Lawrence corridor, and in essence the I-93 bicycle path should not be pursued. As a result of these findings, the highway layout for I-93 has been modified to not include a bicycle path within the I-93 corridor. NHDOT will continue to work with regional and local officials to implement the Bikeway Feasibility Study recommendations.

It should also be noted that Massachusetts is in the process of completing an *I-93 Corridor Traffic Study, Andover and Methuen, Massachusetts* for the section of I-93 from the New Hampshire state line southerly through Methuen and Andover. The study considers a range of alternatives and makes recommendations for further studies and eventual construction in Massachusetts. Although the study report is not finalized, the preliminary recommendations of the Study Advisory Committee call for widening the roadway to four general purpose lanes in each direction and do not include the provision of an HOV facility. The Study also calls for improvements to the Haverhill commuter rail line to allow increased service and a cooperative study by New Hampshire and Massachusetts to consider potential options for rail service between Manchester and Boston.

In 2004, the NHDOT will embark on a Transit Investment Study in conjunction with the State of Massachusetts to consider in more detail the long-term rail and transit needs for the I-93 corridor between Manchester and Boston. The study is expected to help guide future pubic and private investment decisions involving alternative corridors and various modes of public and freight transportation. The study is expected to be completed in the spring of 2006.

1.4 Purpose and Need for the Project

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1.4.1 Purpose

The purpose of this project is to improve transportation efficiency and reduce safety problems associated with this approximately 19.8-mile segment of I-93 between Salem and Manchester. Options including reactivating rail service, improving bus transit service and other Transportation Demand Management (TDM) strategies that reduce vehicle trips on I-93 have been considered, in addition to widening the mainline and reconstructing the interchanges.

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1.4.2 Need

Interstate 93 is a north-south principal arterial Interstate highway within the State of New Hampshire and is part of the National System of Interstate and Defense Highways. I-93 in New Hampshire extends a distance of approximately 132 miles from the Massachusetts border at Salem, New Hampshire to the Vermont border at Littleton, New Hampshire. The segment of I-93 under study intersects a number of the important highway routes in southern New Hampshire. Due to population growth, development, and recreation opportunities in New Hampshire, the travel demands for I-93 between Salem and Manchester have exceeded the capacity of this existing four-lane facility for a number of years. Population and traffic projections for the next twenty years support the conclusion that the existing facility will be increasingly less able to function at the levels of service and safety for which it was

Northbound Between Rest Area and Exit 1.

originally designed. Decreases in the level of service are evident in the reduced traveling speeds, increased density of traffic flow, as well as in the traffic backups at some interchanges during commuting hours.

Traffic backups and congestion routinely occur due to traffic incidents such as accidents and vehicle breakdowns. As one of the main arterials in the New Hampshire highway system, it is important that this roadway function properly to serve all users. The New Hampshire Legislature recognized the need for improving

this highway and included the project in the State Ten-Year Highway Plan when that plan was enacted in 1986.

The purpose and need for this project was formally agreed to in a letter dated January 23, 2001, and signed by the state and federal agencies participating in the Environmental Streamlining partnership established for facilitating the study process.

Traffic Flow and Congestion

During weekday peak hours, motorists traveling along the I-93 corridor currently experience traffic congestion and substantial delay. The congestion not only results in increased travel times, but also contributes to safety problems, as the limited spacing between vehicles does not afford the motorists desired mobility – often leading to frequent and abrupt lane change maneuvers and sudden stops.

I-93 Exit 1 Northbound.

Base year Average Daily Traffic (ADT) volumes for 1997 range from approximately 61,800 vehicles per day (vpd) between Exits 3 and 4 to as high as 104,400 vpd south of Exit 1. The most recent traffic count data (2003) for the area south of Exit 1 shows the traffic volumes have increased from 104,400 vpd in 1997 to 114,000 vpd. Operating conditions during the peak hours of the day are currently poor with the segments of the corridor south of Exit 4 operating at LOS E or F. Interchange operations at Exits 1, 2, 3 and 5 also regularly break down during weekday peak hours.

Without substantial improvements, or dramatically reduced demand, traffic operations are expected to continue to deteriorate under future conditions, as traffic volumes increase. Traffic forecasts for the year 2020 show ADT's ranging from approximately 73,000 vpd between Exits 3 and 4 to as high as 137,000 vpd south of Exit 1 for the No-Build condition. This level of traffic would further increase congestion along I-93, at the corridor interchanges, and along nearby local roadways. This additional traffic would be expected to expand the period of congestion to more hours of the day and to a greater number of days during the year. Accident frequency would be expected to increase as a result of the increased level of congestion.

The ADT's along the segments of I-93 for the 1997 Existing and 2020 Design Year conditions for the No-Build condition are summarized in Table 1-1.

Table 1.1-1
I-93 Average Daily Traffic (1997 and 2020)[1]

Segment	1997 ADT (VPD)[2]	2003 ADT[3] (VPD)[2]	2020 ADT[4] (VPD)[2]
North of Exit 5	69,300	77,000	84,300
Between Exits 4 and 5	64,900	72,000	81,200
Between Exits 3 and 4	61,800	73,000	73,000
Between Exits 2 and 3	74,900	84,000	98,000
Between Exits 1 and 2	81,100	87,000	103,600
South of Exit 1	104,400	114,000	137,000

1 ADT's are based on I-93 Subarea Traffic Model
2 VPD = vehicles per day
3 2003 ADT Per Traffic Count data
4 2020 ADT assumes the No-Build condition.
Note: 2020 ADT projections reflect completion of the Windham-Salem bypass project and associated drop of about 5.000 vpd on I-93 between Exits 3 and 4.

Safety Issues/Crash Data

A review of crash data for the 19.8-mile corridor and the interchanges for the eight-year period of January 1995 through December 2002 revealed a total of 2,427 crashes. Of these, 699 crashes (29 percent) resulted in personal injury with an additional 19 crashes (1 percent) resulting in a fatality. The remaining 1,709 crashes (70) percent resulted in property damage only.

The number of crashes that occurred between 1995 and 1997 revealed a steady decline with the number of crashes each year recorded at 253, 236 and 203 respectively. However, the trend was broken in 1998 when 292 crashes – the highest during the five-year period – were recorded. The number of crashes again declined slightly in 1999 with 243 reported crashes, but rose substantially in 2000, 2001 and 2002.

The segment of I-93 between Exits 3 and 4 recorded the highest number of crashes with 675 crashes (28 percent). Three-hundred ninety-seven crashes (16 percent) were

recorded between Exit 5 and I-293. The segments between Exits 4 and 5, and between Exits 2 and 3 recorded 306 crashes (13 percent) and 284 crashes (13 percent), respectively. The segments between Exit 1 and Exit 2, and between the MA state line and Exit 1 recorded the fewest crashes with 247 (10 percent) and 234 (10 percent), respectively. The number of crashes that occurred at each of the interchanges range from a low of 36 at I-293 to a high of 49 at Exit 5. It is important to note that due to reporting practices the location, and to some degree the total number, of crashes is not, in many cases, available. Some of the crashes that have been identified as occurring along a segment of I-93 may have occurred at, or close to, an interchange.

Geometric deficiencies exist within the corridor and may be a contributing factor in some of the reported crashes. Each of the interchange areas has some ramps with less than desirable grades and some acceleration and deceleration lanes with less than desirable lengths. In addition, the mainline grades are also greater than the desirable maximum grades at several locations along the corridor. As traffic continues to grow, the existing deficiencies will become more of a problem.

2 Alternatives

2.1 Introduction

This chapter provides a summary of the various alternatives identified as potentially satisfying the stated purpose and need of the project. The screening process used to select a reasonable range of alternatives is described along with a detailed explanation of each alternative including No-Action (or No-Build Alternative). A summary of the environmental consequences of each alternative from Chapter 4 is also provided and the Selected Alternative identified.

2.2 Project Scoping

Scoping is the identification of the issues and range of alternatives to be considered in the EIS. This was accomplished for the present project through correspondence, telephone calls and formal and informal meetings with federal, state and local agencies and officials. Formal Scoping meetings for which notices were published in the Federal Register and local papers, were held on May 19, 1992, and December 6, 2000. At the first meeting, a number of questions were raised relative to traffic projections and how traffic on I-93 might influence traffic volumes on other state highways. Ultimately, it was decided the study would be put on hold until after the Statewide Transportation Model could be created to address the traffic issues.

The second Scoping Meeting was held after the study had been re-initiated and the *Scoping Report (VHB, May 2000)* published. The second meeting was held to provide an opportunity to formally take comment on the purpose and need of the project, the study area under consideration, the alternatives considered and the key issues involved. Key issues focused primarily on how secondary impacts would be evaluated and addressed and the need to fully evaluate rail as an option to highway widening. In addition, a number of Advisory Task Force, Public Informational, and Resource Agency meetings were held prior to, and since the second Scoping Meeting, to foster public participation in the process.

2.3 Alternatives Considered

Conceptual alternatives were identified and discussed in the *Scoping Report (VHB, May 2000)* and the subsequent *Rationale Report (VHB, January 2001)*. These alternatives provided a range of potential solutions or actions to address the purpose and need of the I-93 Salem-Manchester project. The six basic types of alternatives were:

- No-Build,
- Implementation of Transportation System Management (TSM) actions, see Section 2.3.2,
- Providing additional lanes to the existing highway (highway widening),
- Implementation of Transportation Demand Management (TDM) strategies, see Section 2.3.4,
- Providing alternative modes of transportation (a form of TDM),
- A combination of these.

Alternative highway corridors involving the relocation of I-93 (or sections thereof) to bypass existing I-93 were not considered viable options because of the magnitude of investment required, presumed environmental impacts, and current traffic patterns associated with the existing facility.

The following sections describe each of the basic types of alternatives.

■

2.3.1 No-Build

The No-Build Alternative is essentially the continuation and perpetuation of the existing situation and the shortcomings inherent on the present highway corridor. Given the base year 1997 Average Daily Traffic (ADT) volumes, which range from 61,800 vehicles per day (vpd) between Exits 3 and 4 to 104,400 vpd south of Exit 1, and the projected 2020 No-Build ADT volumes, which range from 73,000 vpd to 137,000 vpd at the same locations, this alternative would not meet the project purpose and need, and in fact would result in a worsening situation relative to transportation safety and mobility. As such, the No-Build Alternative is not considered a viable alternative, but does serve as a baseline condition for comparison with other alternatives.

■

2.3.2 Transportation Systems Management

Transportation Systems Management (TSM) refers to short range, moderate cost measures aimed at reducing congestion and enhancing safety on the existing transportation system or roadway network. Generally, these measures involve little or no right-of-way impacts. Such measures might include adding traffic signals, modifying traffic signal timing or phasing, adding or extending turn lanes within the existing right-of-way, improving acceleration and deceleration lanes, restriping of existing pavement markings, and the incorporation of turn restrictions. In addition, Intelligent Transportation System (ITS) technology, such as variable message boards and emergency communications, can be considered.

In general, TSM improvements cannot address the long-term safety and capacity needs of a highway, but can provide some short-term relief in advance of the ultimate solution.

This section describes the specific TSM improvements that were investigated for the I-93 project including an analysis of ramp metering and shoulder lane use as possible TSM measures.

2.3.2.1 Interchange Geometry Improvements

A number of TSM improvements associated with the interchanges along the study corridor were evaluated (**Figure 2.3-1**).

Exit 2

The relatively short length and steep grade of the northbound on-ramp at Exit 2 can be problematic. The ramp grade (approximately 4 percent) combined with the relatively high percentage of truck activity (11 percent in the morning peak hour) can result in congestion and create potentially hazardous conditions as motorists caught behind slow moving trucks attempt to pass trucks at the gore area in an effort to enter the highway. In addition, the signalized northbound and southbound Exit 2 ramp intersections with Pelham Road (NH 97), as well as the nearby intersections of Pelham Road with Keewaydin Drive and North and South Policy Street, currently operate at or close to capacity.

To address the deficiency at the Exit 2 northbound on-ramp (**Figure 2.3-2**) a TSM option would be to extend the northbound on-ramp to provide greater distance and time for truck traffic to get up to speed before entering the highway. Note that this action would not address the LOS F operation of the merge movement during the evening peak hour, but would enhance the safe and efficient operation of the ramp merge.

In addition to extending the northbound ramp, the Town of Salem with participation from the State proposes to upgrade Pelham Road at the Exit 2 Interchange (**Figure 2.3-3**) in 2002. These modifications include widening Pelham Road to a 4-lane section and upgrading the Pelham Road/ Keewaydin Drive/Southbound ramp intersection, the Pelham Road/Stiles Road/Manor Parkway intersection, and the Pelham Road/ northbound ramps intersection. These modifications would provide one additional lane (resulting in a four-lane section) along Pelham Road through these intersections to provide for more traffic throughput at the intersections. Pelham Road, between the ramp intersections, would consist of two through lanes in the westbound direction, and a single through lane and an exclusive left-turn lane in the eastbound direction. A 2- to 4-foot shoulder would be provided on each side with a 5-foot sidewalk along the south side of the roadway. These modifications would substantially improve the operating conditions along Pelham Road over the near term.

Exit 3

At Exit 3, the intersections of NH 111 with the northbound and southbound ramps currently operate at capacity (LOS E) during the evening peak hour. The proximity of the NH 111/NH 111A intersection to the NH 111/northbound ramp intersection combined with the capacity constraints of the NH 111/northbound ramp intersection results in substantial delay and long vehicle queues along NH 111 and along the northbound off-ramp. In addition, unsignalized left-turn exiting movements from the southbound off-ramp onto NH 111 westbound operate at LOS F with long delays. However, the relatively low left-turn volume (75 vehicles during the morning peak hour and 70 vehicles during the evening peak hour) does not justify the installation of a traffic signal.

To address the deficiency at the Exit 3 northbound off-ramp (**Figure 2.3-4**), a TSM option would be to widen the off-ramp to provide double left-turn lanes. This concept is currently under design as part of the NH 111 Windham-Salem (10075) project. In addition, improved traffic signal coordination could be provided between the northbound off-ramp signal and the signal at the NH 111A/NH 111 intersection, located 500 ft to the east. With these modifications, the northbound off-ramp intersection would operate at LOS C in the evening peak hour.

At the southbound ramps (**Figure 2.3-5**) a recommended TSM option would be to extend the right-turn lane on the NH 111 eastbound approach to the intersection to better delineate and channelize the right-turn movement onto I-93 southbound. This action would allow motorists who are turning left onto NH 111 westbound from the I-93 southbound off-ramp to better distinguish the eastbound right-turn movements from the eastbound through movements. This improvement would enhance the safe and efficient operation of the intersection. In addition, the acceleration lane where the southbound on-ramp meets I-93 could be extended (**Figure 2.3-6**) to improve the merge between the ramp and the mainline. Installation of a traffic signal at the Southbound off-ramp/NH 111 intersection is not proposed as a TSM option because traffic volumes on the ramp are relatively low and the westbound approach on

NH 111 does not have enough room to provide two through lanes and an exclusive left-turn lane required to keep the intersection operation acceptable.

Exit 4

At the Exit 4 Interchange, the signalized northbound and southbound ramp intersections with NH 102 operate at acceptable levels of service. However, during the evening peak hour the NH 102 eastbound left-turn movement at the intersection with the northbound on-ramp can experience queues that exceed the available storage. A TSM option would be to extend the storage for the left-turn lane by approximately 300 feet (**Figure 2.3-7**). This could be accomplished by modifying the existing raised median.

Exit 5

The signalized northbound and southbound ramp intersections at Exit 5 operate at capacity (LOS E) during the peak hours of the day. Motorists experience delay on all approaches. However, from a safety perspective, the immediate need would be to address the existing problem of vehicles queuing back onto the I-93 southbound mainline from the southbound off-ramp. During the weekday evening peak hour, vehicles often queue back onto the shoulder area along the I-93 southbound approach to the off-ramp.

To address the queuing problem at the southbound off-ramp (**Figure 2.3-8**) a TSM option would be to lengthen the ramp and widen the shoulder area approaching the off-ramp to provide additional storage for these vehicles. This location would require a more substantial interim modification awaiting the long-term interchange reconstruction. The interim solution would likely require some widening of the existing railroad bridge just north of the southbound off-ramp to accommodate a longer ramp. The southbound off-ramp would also be widened to allow for proper separation of exiting and through vehicles. Retaining walls and special slope treatments would also be required to minimize impacts to surrounding wetlands.

Signal timing at the interchange intersections (**Figure 2.3-9**) could also be modified to provide additional green time to the off-ramp movements. Loop detection could be placed at the beginning of the off-ramp to detect the presence of queued vehicles and enhance the operation of the ramp intersections. The solution would in all likelihood increase the queuing along NH 28. However, because speeds are slower on NH 28 than along I-93, this would improve safety.

As an interim improvement to reduce the tendency of the southbound off-ramp queue to back up into the highway, NHDOT will be replacing the traffic signal controller that currently controls the traffic signal phasing and timing at the interchange. The new traffic signal controller will allow for the implementation of more efficient signal-phasing. Specifically, NHDOT will be implementing a phasing scheme that would allow the Route 28 eastbound left-turn movement onto the northbound on-ramp to occur under the same phase as the left-turn from the

southbound off-ramp. Similarly, the Route 28 westbound left-turn movement onto the southbound on-ramp would occur under the same phase as the left-turn from the northbound off-ramp. This signal phasing modification is expected to reduce overall delay at the interchange by reducing the potential of excessive queuing and blockage between the ramps on Route 28.

2.3.2.2 Ramp Metering

The primary objective of any freeway control technique is to improve the safety and efficiency of mainline freeway operations by reducing the factors that increase freeway congestion. One method in freeway traffic control is freeway entrance ramp metering, commonly known as ramp metering. Ramp metering controls the access of vehicles into the mainline flows so that the vehicles entering upstream of the area of traffic flow to be managed are approximately proportional to the vehicles exiting downstream of the area. The purpose is to regulate freeway demand so that demand does not exceed highway capacity.

Control is provided via signalized entrance ramps which delay drivers entering the highway so that flow on the highway can be maintained at an acceptable level of operation. Ramp metering balances the overall traffic flow by regulating ramp demand in proportion to freeway capacity. Drivers trying to enter the highway must wait in the resulting queue and may be encouraged to find either another:

- point of entry,
- route,
- time to enter the freeway, or
- transportation choice.

Entrance ramp control operations can be subdivided into two main types, known as 'pre-timed metering' and 'traffic-responsive metering'[4]. Pre-timed metering, the most common form, is when the ramp meter rate is set as the difference in vehicles per hour (vph) between downstream capacity and upstream demand, based on historical volume data[5].

Traffic-responsive metering differs from pre-timed ramp metering in that the ramp meter rate is reflective of the current available capacity, which is based on 'real-time' monitoring of upstream and downstream traffic flows. Additional vehicle detectors placed either before the ramp meter for queue detection or after the meter for monitoring merge conditions can increase the efficiency of the meter operations. When several meters are linked together, the ramps respond to the entire freeway condition rather than the local condition, this is known as an 'integrated system

[4] Transportation and Traffic Engineering Handbook, ITE, Chapter 25, pages 786-798, 1982.
[5] Same as above.

control'. Institute of Transportation Engineers (ITE)[6] studies have shown that responsive metering connected to a central control station can result in lower travel times, fewer crashes and higher total travel.

Ramp metering can also be used to encourage alternative transportation choices such as high occupancy vehicle (HOV) lanes. HOVs can be allowed to bypass the ramp queue. This is known as priority access control and it encourages carpools, vanpools, and transit use. Encouraging these travel modes has the net effect of lowering overall vehicular demand on the freeway while still serving the same number of people.

Advantages/Disadvantages

There are several advantages offered by ramp metering. The regulation of vehicles entering the main line flows presents drivers with a set of consistent operation parameters that they can easily adapt to and provide the following benefits:

- More consistent freeway flow speeds, which result in less air pollution.
- Utilizing freeway corridor capacity more efficiently by eliminating bottlenecks at ramp entrances, where heavy entering traffic disrupts mainline flow.
- Reducing the number of congestion related collisions that occur when drivers are forced to compete for gaps in the traffic flow.
- In the case of traffic response metering, there is an added benefit of being able to respond to variable conditions such as a weather or traffic incidents.
- An integrated system optimizes the traffic flow over an entire corridor thereby increasing efficiencies at the local level as well as over the entire system. If traffic response metering is utilized, traffic flow through the entire system could be optimized for the given capacity.
- Vehicle queue sensors would increase meter rates and balance ramp demand with queue storage thereby reducing spillover to local roads.

Disadvantages of ramp metering include:

- Limited freeway entrances could cause substantial queues at metered entrance ramps because of lack of alternative routes. If there is inadequate storage area, such queuing may extend onto local roadways and interfere with non-freeway traffic.

[6] Same as above.

- Increased delay at metered ramps may divert traffic to other ramps and roadways, shifting congestion to other locations.

- Increased delay at metered ramps may divert traffic to travel at a different time of day, extending the hours of congestion and inconveniencing drivers.

- Existing interchanges with insufficient geometric capacity may require costly upgrades to provide sufficient storage capacity to prevent queuing onto local roadways.

- The need to provide enforcement of ramp meters to prevent cheating that will reduce the effectiveness of the meters.

According to the *Manual on Uniform Traffic Control Devices*[7], there has been insufficient experience with ramp metering to permit development of numerical warrants applicable to the wide variety of conditions found in actual practice. However, guidelines have been suggested for successful application of controls. Installation of freeway entrance ramp controls may be warranted when:

- The reduction in freeway delay exceeds the delay to ramp users and drivers on alternative routes.

- There is adequate storage space for queued vehicles.

- There are suitable alternative routes.

- There is recurring freeway congestion due to demand exceeding capacity or there is recurring congestion or accident hazard at the freeway entrance because of an inadequate merge area.

2.3.2.3 Shoulder Lane Use

The use of shoulders, or breakdown lanes, as travel lanes has been in existence in the United States since the late 1960s. More than 24 states have implemented projects involving the use of shoulders as a means of providing additional travel lanes and capacity since that time. Typically, opening shoulder lanes for travel during peak hours is primarily viewed as a temporary solution to peak period congestion until the permanent solutions are constructed.

Using the existing shoulders along I-93 in New Hampshire as a travel lane was considered as a possible short-term TSM option to help relieve congestion during the

[7] The Manual on Uniform Traffic Control Devices (MUTCD) is approved by the Federal Highway Administrator as the National Standard in accordance with Title 23 U.S. Code, Sections 109(d), 114(a), 217, 315, and 402(a), 23 CFR 655, and 49 CFR 1.48(b)(8), 1.48(b)(33), and 1.48(c)(2).

peak travel period of the day. Based on a review of the existing traffic operations for I-93, the area that was of particular interest to evaluate the use of a shoulder lane treatment was the northbound section of I-93 between Exit 1 (Rockingham Park Boulevard) in Salem and Exit 3 (NH 111) in Windham, a distance of 3.9 miles. This section regularly experiences congestion in the evening peak period. Between the state line and Exit 3 the I-93 northbound barrel consists of four lanes south of Exit 1 and two lanes immediately north of Exit 1. This narrowing of the highway in conjunction with the short distance between interchanges makes this section of I-93 particularly susceptible to congestion. There are three interchanges in this segment and the posted speed limit is 65 miles per hour (mph) north of Exit 1 and 55 mph south of Exit 1.

Accommodating the use of the shoulder along I-93 northbound between Exits 1 and 3 for peak period travel would require widening the entire 3.9-mile corridor to provide a minimum 12-foot shoulder. Additional widening in specific locations would also be necessary to provide sufficient clear distance from obstacles along the edge of roadway and to provide for emergency vehicle pulloffs.

In addition to the mainline treatment, there are four bridges that would need to be widened, and three where modifications to elements (stone slope protection, guardrail or concrete barrier) beneath the bridges would need to be modified to provide the necessary highway width to allow traffic to use the shoulder as a through lane during peak periods of congestion. In total, the highway width would be a minimum of 42 feet to accommodate a 4-foot median shoulder, two 12-foot travel lanes, a 12-foot shoulder lane, and a minimum 2-foot offset to a guardrail or concrete barrier.

Advantages/Disadvantages

A review of the shoulder use issue and existing conditions along I-93 north from the Massachusetts/New Hampshire border to Exit 3 include the following:

- Safety statistics associated with other locations, where the shoulder is used as a means of increasing capacity, indicate that there is a general statistical increase in traffic accidents associated with the usage of the shoulders as travel lanes. However, as drivers become more familiar with the use of the shoulder as a travel lane, accident rates decline over time (although accident rates remain higher than pre-usage periods).[8]

- Incident response is an important issue to consider in determining if a shoulder lane should be implemented. In the event of an incident along I-93 which requires emergency response, it is likely that the traffic flow through the shoulder portion of the roadway will also be affected by the incident. Under these situations, it will be difficult for emergency personnel to respond quickly.

[8] Report 369 - Use of Shoulders and Narrow Lanes to Increase Freeway Capacity; National Cooperative Highway Research Project, Transportation Research Board; Washington DC 1995 Safety Implications of Using Highway Shoulders as Travel Lanes; Alicia Powell Wilson, Central Transportation Planning Staff; Boston, Massachusetts; April 1997.

- Since the existing traffic volumes and operations indicate that I-93 within the study area is currently over capacity, the corridor could benefit from peak period use of a shoulder lane as a temporary traffic management solution. However, as described below, given existing physical constraints along the corridor, this is not a quick or low-cost alternative.

- Maintenance is another issue that arises with the implementation of a shoulder lane, the maintenance of the northbound lanes will be limited to off-peak periods.

- Based on the recommended minimum cross-section, there is inadequate width to accommodate the proposed use of the shoulder over the 3.9 miles between Exits 1 and 3, without widening the entire roadway corridor by an average of two to four feet.

- If a shoulder lane were to be opened to traffic, the friction between motorists entering and exiting the highway will increase due to the reduction in the acceleration and deceleration areas.

- The availability of an effective clear zone along the outside shoulder of I-93 will be affected by shoulder lane use. The clear zone is defined as an area free of obstructions adjacent to the travel lanes and by definition includes the shoulder. Clear zones provide a driver the opportunity to either recover control of a vehicle that has left the paved roadway or to stop in case of emergency. The use of a shoulder lane as a temporary travel lane will reduce the available clear zone between the travel way and the roadside obstructions where they exist.

Much of the widening for the shoulder lane between Exits 1 and 2 would also require additional widening beyond the shoulder lane pavement to accommodate guardrail due to the steep fill slopes. This widening would result in impacts to wetlands, including designated prime wetlands, adjacent to I-93. The section of I-93 between the Pelham Road bridge and the Brookdale Road bridge (approximately 3,000 feet) would require additional widening due to the narrowness as the Exit 2 NB on-ramp merges with the mainline. The northbound on-ramp at Exit 2 would also require reconstruction to accommodate the additional width for the shoulder lane.

Based on the AASHTO recommended minimum pavement cross-section, the I-93 northbound bridges over Porcupine Brook, NH 38, Pelham Road, and NH 111A between Exit 1 and Exit 3 would require widening of approximately four feet to accommodate the 42-foot width needed.

At the Brookdale Road bridge over I-93 NB, the existing 10-foot shoulder under the bridge would require widening and modifications to accommodate the installation of guardrail or barrier protection to allow for the use of the shoulder lane.

In the area of the two Rockingham Park Boulevard bridges over I-93 NB, the existing easterly travel lane shoulder field measures 11 feet wide with a 2-foot offset to existing guardrail. This shoulder would need to be widened one foot and the existing guardrail replaced with a concrete barrier offset at two feet from the easterly travel lane shoulder.

Pull-off locations for emergency situations when shoulders lanes are in use would be required. By using the shoulder as a through lane, the ability for vehicles to exit the travel way under emergency conditions is limited. Space for disabled vehicles is limited to emergency pulloff areas. Disabled vehicles that cannot access the emergency pulloff may be forced to stop in the shoulder lane creating an unsafe situation for the driver of the disabled vehicle as well as the shoulder lane vehicle who is forced to maneuver around the disabled vehicle. At a minimum, emergency pulloff areas would need to be provided every 2,500 feet. The pulloffs would require additional highway widening potentially creating additional resource and property impacts.

Problems created with shoulder use lanes include general confusion by motorists, lack of a recovery area, lack of a place for disabled vehicles other than at the areas spaced 2500 ft apart, and lack of space for maintenance vehicles to work safely along the highway.

Additional clearance to fixed objects on the side of the roadway would also need to be provided. Guardrails and barriers must have a 2-foot minimum clearance from the edge of pavement, while breakaway signs require 6-feet of clearance.

- The proximity of the interchange spacing between Exits 1 and 2 would reduce the effectiveness of shoulder lane operating conditions and increase safety concerns associated with traffic exiting and entering I-93 in this area.

- I-93 between Exits 2 and 3 is not desirable for shoulder lane use. The 4-5 percent grades in combination with near maximum roadway design curvatures further compromise safety relative to shoulder lane use.

The implementation of shoulder lanes north of Exit 3 and along the southbound barrel of I-93 between Exits 1 and Exit 5, although not fully evaluated, would face similar difficulties as discussed in the preceding text. The need to widen bridges, improve clear zone offsets, and provide for emergency pulloffs would be similarly problematic.

2.3.2.4 Intelligent Transportation Systems (ITS)

Intelligent Transportation Systems (ITS) are potential TMS strategies that could contribute to reducing congestion and improving the safety of the I-93 corridor. Such contributions could help the current situation, the situation during the reconstruction and widening process, and over the long term following the completion of the widening. ITS are typically considered to be Transportation System Management

(TSM) improvements, but they can also serve Transportation Demand Management (TDM) (Sec. 2.3.4) strategies to address the needs of the corridor.

Intelligent Transportation Systems are applications of information processing, communications, control, and electronics to improve the efficiency and/or safety of a surface transportation system. While ITS technology may not eliminate the need to expand the physical infrastructure, it can make an important contribution on how efficiently the infrastructure is utilized.

Examples of how ITS technologies can contribute to efficient utilization of the infrastructure are as follows:

- Collect and transmit information on traffic conditions and transit schedules for travelers before and during their trips. Alerted to hazards and delays, travelers can change their plans to minimize inconvenience and additional strain on the system.
- Decrease congestion by reducing the number of traffic incidents, clearing them more quickly when they do occur, rerouting traffic around them.
- Collect turnpike tolls automatically, helping reduce delays at toll plazas.
- Improve the productivity of commercial, transit, and public safety fleets using automated tracking, dispatch and weigh-in-motion systems that speed vehicles through administrative checks and efficiently manage vehicle fleets.

Most ITS deployments have been in major metropolitan areas such as Minneapolis, New York, Los Angeles, etc. New Hampshire on its own and in concert with other states is developing and utilizing Intelligent Transportation Systems technologies that are appropriate to its less urbanized needs. The I-93 corridor presents an opportunity to make further use of ITS technologies before, during and after the highway reconstruction takes place.

2.3.2.4.1 ITS Initiatives in New Hampshire

Among the initiatives currently underway in New Hampshire are the following:

Tri-State ITS Program

The Tri-State Rural Advanced Traveler Information System (Trio) is a cooperative program being undertaken by New Hampshire, Maine and Vermont to develop a regional traveler and tourism information system based on ITS technologies.

Trio's vision is to help provide an improved quality of life for residents and visitors promoting enhanced access to appropriate economic and social activities through the judicious application of Intelligent Transportation Systems (ITS).

Trio's goals include the promotion of economic development through more efficient operation of the highway network, improving access to activities and services, and helping facilitate a safe transportation experience for visitors and residents. Trio also seeks to enhance the region's special environment, preserve community values and reduce energy consumption.

In 2001, Trio held stakeholder meetings across the Tri-State region to identify transportation and tourism needs that can be addressed by ITS. Now, a "Statewide Base System" of real-time traveler and tourism information is being deployed across Northern New England. Trio's approved Implementation Plan envisions that infrastructure deployments, such as I-93, will quickly follow. Various statewide enhancements may then be added over the remainder of the initial five-year period.

The "Statewide Base System" comprises three regional information subsystems that can work directly to assist travelers in the I-93 corridor. The first, Condition Acquisition Reporting System (CARS), includes construction, incident, accident, delay and tourism event information. The second, Foretell, covers road and weather conditions across the Tri-State Region, including road condition prediction out to 30 hours ahead. The third system will provide for public access to these information databases on the Internet. These three ITS systems will allow I-93 travel reports to be viewed within a wider, multi-state traveler information framework.

Electronic Toll Collection

The NHDOT is proposing to convert its toll collection systems to allow the option of electronic toll collection on turnpikes using Intelligent Transportation Systems technology. Electronic toll collection allows drivers to attach a toll tag to the windshield of their vehicle that is recognized automatically in specially-equipped toll lanes. Each driver has an account with the NHDOT which must be kept in credit. Users are able to replenish their accounts automatically through the use of a credit card.

Although electronic toll collection will not directly impact I-93 between Salem and Manchester, it should enhance the overall efficiency of the corridor, encouraging motorists to utilize the corridor as opposed to alternative routes. Toll tags can also serve as a traffic management tool if, by agreement with users, additional toll readers are used to track traffic routing through congested sections, as is currently happening around New York City. Many New Hampshire motorists will become familiar with Intelligent Transportation Systems as a result of electronic toll collection, which can serve as an introduction to further ITS opportunities.

Incident Management Initiative for the I-93 Corridor

The worsening congestion along the I-93 corridor between Salem and Manchester is routinely compounded by major and minor incidents (crashes and breakdowns). In response NHDOT in cooperation with FHWA began discussions in 2000 with State

Police and local safety (police, fire, ambulance, towing) officials to improve upon Incident Management Procedures. The management of incidents was largely a set of individual protocols based on the local practices of those responding to specific circumstances. Response activities focused on the incidences themselves, with the motoring public a secondary consideration. Long delays, secondary incidents, and traffic diversions on secondary highways were becoming more problematic.

The Incident Management Initiative for the I-93 corridor has involved training seminars for state and local safety, environmental, and highway staff; monthly meetings with all stakeholders to develop incident management procedures; and the development of near term and long term goals and objectives for continued improvement in incident management relative to response time, minimizing traffic delays, and addressing traffic diversion issues. Among the near term results are the following:

- Recognition that communication procedures and equipment need to be improved.
- State and local officials are re-evaluating response procedures and sectional responsibility.
- Emergency Reference Markers have been installed to improve a driver's ability to accurately locate incidents along the corridor and to more accurately convey the location of an incident to emergency personnel and improve emergency response time to the scene.
- Quick clearance of a scene is being re-evaluated to reduce future delays.
- The towing industry support function is being re-evaluated.
- Improved coordination with the NHDOT has occurred.
- There is increased understanding and awareness of each agency's functions and capabilities and a greater emphasis on cooperation.
- Local agencies have identified areas that would improve their ability to provide emergency services, such as additional access points and dry hydrants at bridges.

The long-term solutions for the I-93 corridor are being pursued within the framework of a Statewide Incident Management Protocol for which the I-93 corridor serves to some degree as a test case. Among the ideas being pursued are the following:

- Formalize and continue the monthly meetings to further the improvements in coordination and cooperation among the State and local agencies, departments, and service providers.

- Evaluate and deploy ITS technologies to effectively monitor and control traffic movements along the corridor.
- Utilize the Tri-State Rural Advanced Traveler Information System (Trio) being developed to provide real time information to travelers.
- Establish a Traffic Control Center to monitor traffic movement along this and other major corridors in the State. This is moving forward as a component of a Statewide Emergency Operations Center being developed in conjunction with the Department of Safety.
- Coordinate ITS implementation with local ITS initiatives that are being proposed by the Town of Salem involving signal coordination and a centralized command center.

More specific to the I-93 corridor, and with consideration of existing needs, incident management during construction, and incident management over the long term following construction, the following recommendations will be considered:

Pre-Construction

- Expand the current level of community involvement.
- Address communication issues and needs.
- Finalize additional points of emergency access to the corridor.
- Implement a program to install dry hydrants at appropriate locations.
- Upgrade guide signing along alternative detour routes.
- Develop a detailed detour plan that would include implementation criteria and variable message signs.
- Evaluate existing intersections/roadway sections and develop plans to improve capacity where appropriate.
- Formalize response procedures to incidents, evaluate their effectiveness and modify as required.
- Continued evaluation of the effectiveness of Emergency Reference Markers, previously installed on the I-93 corridor from the Massachusetts state line to Manchester.

Construction

- Include Incident Management Procedures as part of the construction documents and specifications for the widening project. These could involve service patrols of the construction zones, pre-positioned tow trucks along the highway to facilitate rapid incident removal and other protocols.

- Utilize ITS Technologies as appropriate and evaluate their effectiveness.

- Include Incident Management infrastructure in the overall layout for widening improvements, such as additional emergency access points, dry wells, conduit, sensors, etc.

Post-Construction

- Continue the coordinated Incident Management Practices implemented in the pre-construction and construction phases.

- Expand ITS Technologies as appropriate.

- Continue to use this corridor as a "test case" for new technologies and other Incident Management Practices.

2.3.2.4.2 ITS Opportunities for I-93 in Southern New Hampshire

Planning for ITS deployments specific to I-93 in southern New Hampshire is continuing as part of the second stage of the Trio Implementation Plan, addressing infrastructure deployments. The current planning is a continuing refinement of the broader, top-level ITS plan for the State to a more detailed and specific level of implementation and deployment. Deployments will be done before, during, and after construction. Potentially appropriate ITS technologies cover two main functions, information collection and information dissemination. Information collection tools typically involve traffic flow counters, road-weather information systems, real-time vehicle location systems to track bus or construction / maintenance vehicle progress, video cameras, and cellular phone reports from commuter volunteers. Information dissemination tools could include changeable message signs, highway advisory radio, internet, cable TV, and telephone information systems. Details of these technologies are presented under Transportation System Management (TSM) options below.

Information Collection Options

Information technology offers a variety of data collection tools that can be used as part of TSM deployments.

Automatic Traffic Recorders

Automatic traffic flow counters are already used at many locations in New Hampshire, including points along I-93. Traffic counters provide background information on traffic flows for uses such as transportation planning, accident analysis and validation of toll receipts. Traffic count data can be used in real time to help monitor roadway usage and predict congestion in advance. Automatic counters can be supplemented by truck classification or weigh-in-motion devices where heavy traffic has important effects on roadway capacity.

There are two existing traffic counting sites on I-93 close to the New Hampshire/ Massachusetts state line, one in Salem (south of Exit 1) and one in Windham (between Exits 3 and 4) with additional sites north of Manchester (**Figure 2.3-10**). To provide for automated incident and congestion detection, additional monitoring sites could be installed at more frequent intervals along the corridor. Providing detectors every one-half mile would require 32 additional mainline locations. Optionally, sites could also be located on exit ramps. These traffic monitoring sites would allow early detection of incidents and other traffic delays along the I-93 corridor.

Cameras

Video cameras often have a role in strategic corridors. Video images can be used to assess incidents once the initial detection has occurred using traveler reports or automated systems. Providing video images to travelers via the Internet or kiosks has also proved to be extremely popular with system users and substantially increases the users' confidence in related traveler information. Finally, after the events of September 11, 2001, it should be noted that such camera systems can offer security benefits. They are accepted and utilized in European countries that have suffered from intermittent terrorist attacks over the last three decades.

The proposed video camera sites will be determined by conducting a field survey considering a full coverage of I-93 to the extent possible. Overall, approximately 59 video camera sites are being considered along the I-93 corridor in order to achieve this goal (**Figure 2.3-11**). If cameras are linked to traffic flow counters, they can be used to identify the problem when an automatic congestion alarm is raised. This allows a response team to be swiftly dispatched to deal with an incident before delays become severe.

Road Weather Information Systems (RWIS)

Road-weather information systems can monitor roadway temperatures, wind speeds and rain or snowfall in real time. This information can help motorists be informed about driving conditions before they use the I-93 corridor. The information will also help NHDOT operations staff make timely decisions on required winter maintenance actions, so that operating capacities can be maintained even in adverse weather situations. Finally, the information provides an important input to regional road

weather prediction systems such as Foretell, being deployed as part of the regional ITS Statewide Base System.

Two road weather stations are proposed along the I-93 Corridor in southern New Hampshire, one north of Manchester between Exits 11 and 12, and the other near the Massachusetts state line, between Exits 1 and 2 (**Figure 2.3-12**). These two sites will form part of a regional network of stations giving early warning of adverse weather as it begins to cross the region.

Automatic Vehicle Location (AVL)

Vehicle location systems can track buses, construction vehicles or maintenance vehicles to help achieve increases in safety and efficiency. Bus locations can support real-time transit arrival information systems. Maintenance and construction vehicle tracking can offer safety benefits and management efficiency returns as part of integrated information systems for use by contractors and winter maintenance supervisors.

The NHDOT will work with transit operators and construction contractors to identify the vehicle fleets that should be equipped with location systems. Rather than equipping only the specific buses operating in the I-93 corridor, the transit location equipment may form part of a wider, regional transit management and information system. This would give greater flexibility to operators in redeploying equipment as needs arise, as well as serving the public with real-time transit information throughout the region.

Condition Acquisition Reporting System (CARS)

The Condition Acquisition and Reporting System (CARS) uses the World Wide Web to allow authorized users to input construction, accident, delay, and other roadway, weather and tourism event information into statewide databases **(Figure 2.3-13)**. The NHDOT is working with State and local police to track major roadway events as they happen. Data may also be entered by authorized town and city agencies, transit dispatchers, and freight companies.

The CARS statewide traffic event database provides a central source of up to the minute information on current roadway conditions. The database will support each of the various information dissemination systems described in the next section, without the need for manual re-entry of data into each separate system.

Finally, volunteer commuter traffic reporters can provide valuable early reporting of incidents and congestion, often before police or NHDOT staff can reach the incident scene. These volunteers, or designated motorist observers, can be recruited and trained using an approach similar to that of New Hampshire tourism's 'Granite State Ambassadors' scheme, through which volunteers staff help desks and visitor centers. Regular commuters will make their routine journeys, but can call in any unusual incidents by cellular phone. In the future, it may even be possible for voice

recognition software to take messages from trained observers and enter confirmed reports straight into the regional CARS incident database, without further manual intervention.

Information Dissemination Options

Real time traffic data can be disseminated via technologies such as changeable message signs, highway advisory radio, television and telephone information systems. Conventional radio, TV, Internet and Cable channels can also have a part to play.

CARS-511

The Condition Acquisition and Reporting System (CARS) described in the previous section is operable as of May 2003 and supports information sharing between the various agencies that need to coordinate their responses to major incidents. State police, local police, cities, towns, and NHDOT staff pool their incident and response information using this Internet software program. Local officials are able to further utilize real time information to deploy resources to address more localized situations that are the result of delays on the highway (for example, traffic detouring to local roadways to avoid delays). Specialist users, such as transit operators and tow truck companies, can also be allowed access to the information, to help them operate more efficiently. The result of this improved coordination will be more effective incident management, allowing problems to be cleared more quickly and safely.

Internet road reports are automatically updated from CARS to get the information out to the public in homes and workplaces. These reports will include maps showing the location of roadwork or incidents, plus further descriptions of current traffic conditions as necessary. Optionally, video images can also be included with these web pages so that users can see current road conditions directly for themselves.

Public/Private Partnership

Radio and TV stations provide an important public service in disseminating information to travelers, both before and during a journey **(Figures 2.3-14 and 2.3-15)**. The broadcast media can be given real time access to CARS, or can use the public internet road reports and web camera images described above. Cable TV systems can also be encouraged to use public access channels to offer real-time information on regional traffic conditions

Dynamic Message Signs

Dynamic message signs can display traffic incident warnings directly to passing motorists as soon as they are entered into the regional CARS traffic event database. Congestion, weather, driving conditions and other urgent messages can also be

displayed. A two-tier system is proposed to deal with regional and local traffic needs. The proposed locations represent an aggressive deployment strategy that aims to include all the possible decision-point sign locations. However, this approach could be phased due to the high cost of locating dynamic message signs to cover every single decision point on a roadway network.

At the regional level, dynamic message signs will be deployed in advance of strategic intersections on major routes. Major decision points north of the reconstruction corridor are shown in **Figure 2.3-16**. Dynamic message signs in advance of these points will allow drivers to make strategic route choices well before they reach a particular traffic delay. The signs are typically located between a half and one mile ahead of the exit ramp, to allow drivers time to make a decision.

Similar decision points south of the reconstruction corridor are located in Massachusetts. New Hampshire will aim to share regional traffic information with Massachusetts so that any changeable message signs at those locations can be integrated into the wider regional system.

At the local level, dynamic message signs can also be located ahead of other major intersections. In this corridor, signs can be placed on I-93 in advance of Exits 1 to 5, in both directions, so that drivers can make local detours where necessary **(Figure 2.3-17)**. Portable signs can also be used during construction activities or for special events. Each NHDOT Maintenance District has a number of such signs available, that can be integrated into the wider regional system using two-way wireless links.

Finally, dynamic message signs can also be used to provide real-time transit information. Smaller, more detailed signs will be located at the park-and-ride sites along the corridor. These signs can provide real-time bus arrival and departure information to passengers.

Highway Advisory Radio (HAR)\Low Power FM (LPFM)

Highway advisory radio (530 or 1610 kHz AM) is already used at some locations in New Hampshire. Enhanced traveler information services may also soon be possible using longer range, low-power FM stations newly-authorized by the FCC (Federal Communications Commission). CARS can update radio bulletins automatically, minute by minute, so the timeliness and detail of the information will be greatly improved over existing highway advisory radio. Warned in advance, drivers can slow ahead of an incident, maintain lane positions or take other actions to improve safety or avoid delays. Potential low power FM locations are illustrated in **Figure 2.3-18**. In the event of difficulties in obtaining the low power FM radio licenses, AM stations may be used instead.

511 - Travel Information Number

Traveler information phone services using a new, national "511" phone number have also been recently approved by the FCC. The 511 Travel Information number is

available statewide in New Hampshire and travelers are able to call from an office or home phone, or while on the move using hands-free cellular phone technology. Voice recognition allows drivers to request information on particular routes without pressing any touch-tone keys. The I-93 corridor has generally good cellular coverage (**Figure 2.3-19**).

2.3.2.5 Summary and Conclusions

The Transportation Systems Management (TSM) actions will not address all the long-term safety and capacity needs of the highway, however some actions can provide short-term relief in advance of the more comprehensive solution. Specifically many of the interchange TSM actions would, in the short-term, enhance the safe and efficient flow of traffic in the vicinity of the interchanges. In addition, Intelligent Transportation Systems (ITS) technology will be incorporated into the overall improvements to I-93. Such systems will supplement and complement regional and statewide efforts currently underway in New Hampshire, and will serve in the long term to enhance the safety and capacity of the I-93 corridor. Ramp metering is not proposed to be carried forward for further study as its effectiveness relative to improving I-93 would be limited to the southbound barrel in the morning peak period, and the resulting backups on secondary roads within the interchange area would be excessive. The evaluation of shoulder lane use did not support its continued consideration because of safety, cost and construction scheduling issues.

The specific interchange modifications that are to be carried forward and the reasons why the ramp metering and the shoulder lane use will not be carried forward are summarized in the following paragraphs.

Interchange Modifications

Extending the northbound on-ramp at Exit 2 would enhance the safe and efficient operation of the ramp merge. In addition, upgrading Pelham Road, including the widening of Pelham Road to a four-lane section and upgrading the Pelham Road/ Keewaydin Drive/southbound ramps intersection, the Pelham Road/Stiles Road/ Manor Parkway intersection, and the Pelham Road/northbound ramps intersection would substantially improve the operating conditions along Pelham Road.

At Exit 3, the widening of the northbound off-ramp to provide a double left-turn lane is currently under design as part of the NH 111 Windham-Salem project and will improve operations at the intersection. Extending the eastbound right-turn lane on NH 111 at the southbound on-ramp and extending the acceleration lane where the southbound on-ramp meets I-93 would enhance the safe and efficient operation at the intersection and improve the merge operation on I-93.

Extending the length of the left-turn lane on the NH 102 eastbound approach to the northbound ramp at Exit 4 would address an existing queuing deficiency at this location.

Extending the southbound off-ramp at Exit 5 and widening the shoulder area on I-93 approaching the off-ramp would address the existing safety problem of vehicles queuing back onto the I-93 mainline. In addition, the signal timing at the intersection can be coordinated with loop detection on the ramp to detect the presence of queued vehicles.

Ramp Metering

Ramp metering along the I-93 corridor between Manchester and Salem would not provide an effective method of improving traffic operations throughout the corridor. In general, it would only be potentially effective in addressing morning peak period congestion when more traffic generally enters the highway than exits at each interchange.

Ramp metering is generally used in urban areas where alternative travel routes are available. The principal drawback to ramp metering on I-93 in New Hampshire is that there is a limited number of access points to I-93, and thus alternatives are limited for drivers facing long queues at metered ramps. Any diversions would only serve to move congestion to new locations. To the extent that there is no diversion, many ramps would have inadequate storage space to accommodate queued vehicles. This would result in queues extending to local roadways and interfering with non-interstate related traffic.

For these reasons ramp metering as a TSM measure is not proposed.

Shoulder Lane Use

The existing cross-section along the entire 3.9-mile section of the I-93 northbound barrel between Exits 1 and 3 would require some amount of geometric improvements prior to using the shoulder as a means of providing additional capacity. The construction associated with the widening of the corridor and the widening and/or modification of seven bridges would require a substantial capital investment and have potential environmental impacts. While using the shoulder lane as a means of increasing the capacity of the corridor would help in the near-term, it would be a temporary solution only. The use of a shoulder lane is a tradeoff of capacity needs for safety.

Statistically, adding a shoulder lane will lead to an increase in vehicle accidents. The potential increase in accidents will further exacerbate the ability of emergency personnel to respond to an incident in a timely fashion. The construction activities, including traffic control, necessary to complete the construction of the shoulder lane would further disrupt the existing traffic flow and further increase congestion for, in all likelihood, a two-year construction period. The actual use of the shoulder lane, once completed, may have only a one or two year life with the more permanent (albeit phased) solution being contemplated to begin construction in 2004. The capital investment needed to meet the current AASHTO standards for shoulder lane use would be better spent on a more permanent transportation solution, with the completion of the section of I-93 between Exits 1 and 3 given a priority.

For the above reasons, the use of the shoulder as a means of increasing capacity along I-93 northbound between Exit 1 and Exit 3 or elsewhere on this project, was not considered further.

■

2.3.3 Highway Widening and Interchange Improvements

Given the major capital investment of the existing I-93 corridor, all highway design alternatives considered have focused on widening the existing roadway rather than constructing a new facility off-line. Interchange modifications have also focused on reconstructing and modernizing the existing layouts and no new interchanges were considered. It should be noted that a local initiative by the Towns of Derry and Londonderry to construct a new interchange (known as Exit 4A) between Exits 4 and 5 is ongoing. While there is and has been coordination between the NHDOT and the Towns to evaluate issues of commonality and concern, the interchange project has independent utility and is being considered on its own merits within the context of a separate Environmental Impact Statement and the NEPA process. Also note that as part of the Environmental Impact Statement for the Manchester Airport Access Road project, an easterly extension from the Airport to I-93 Exit 5 was considered. The Easterly connection was eliminated from further consideration during the DEIS due to the Londonderry Town Council's opposition to any of the five easterly alternatives.

The alternatives presented in this section are a combination of initial concepts identified in the *Rationale Report* and additional concepts received from the stakeholders during the public participation process. During the development of these alternatives, environmental, socio-economic and engineering constraints were taken into account in an attempt to minimize impacts to resources whenever practicable. As mentioned, these concepts and options were presented, through an on-going series of Advisory Task Force Meetings (ATF), Public Official's Workshops and Public Informational Meetings in each of the corridor communities and at local, State and Federal agency and Resource Agency meetings beginning in the summer of 2000 (see Chapter 8). These meetings were held to explain how and why the various concepts were developed and to receive comments and direction to better understand the needs, issues, and concerns of each of the communities and stakeholders.

2.3.3.1 Description of Highway Build Alternatives

Concepts for addressing existing and future travel demands for the I-93 corridor include adding travel lanes to the existing highway. Alternatives considered involved widening the existing highway from two lanes in each direction to either three or four lanes in each direction. Relative to the widening alternative,

incorporation of high occupancy vehicle (HOV) lanes to serve immediate or future needs was also considered.

Widening the highway to a total of either 3 or 4 lanes in each direction will require consideration of future plans for I-93 in Massachusetts. Today I-93 in Massachusetts, as it approaches the New Hampshire border, is a 6-lane highway (3 lanes in each direction). Recent construction south of Massachusetts Exit 47 (1.3 miles south of the New Hampshire state line) currently allows the highway shoulder to be used as a fourth travel lane during commuter hours. In addition, Massachusetts is in the process of completing a planning study, the *I-93 Corridor Traffic Study, Andover and Methuen, Massachusetts,* which is investigating transportation improvement alternatives along the I-93 corridor between Andover, MA and the New Hampshire state line in Methuen. The Massachusetts study recognizes the travel demand and safety issues along the corridor and acknowledges the need for widening the highway from three lanes in each direction to four lanes in each direction and eliminating the use of the shoulder lane in Massachusetts.

At the northern terminus of the project study limits in Manchester, I-93 is a 6-lane highway (3 lanes in each direction) with additional lanes to accommodate the weaves and ramps necessary for the I-93/I-293/NH 101 Interchange and highway splits and merges in the Manchester area. West of I-93, as part of another project approximately 2.3 miles of I-293 is currently being reconstructed and widened from 2 lanes in each direction to 3 lanes in each direction. Adding additional lanes south of the I-93/I-293/NH 101 Interchange will require some additional pavement in the interchange area to provide efficient and safe transitions.

Current interchange configurations and connecting roads within the study area were evaluated for potential design improvements to accommodate the widening and existing and projected traffic demand, based on current AASHTO and NHDOT design standards. They were also evaluated independently for possible improvement as Transportation Systems Management (TSM) measures (see Section 2.3.2.).

The widening concepts that were considered included three Build Alternatives: a Four-Lane Alternative (four northbound and four southbound lanes) from Salem to Manchester; a Three-Lane Alternative (three northbound and three southbound lanes) from Salem to Manchester; and a Combination Alternative. The Combination Alternative is comprised of elements from both the Four-Lane and the Three-Lane Alternatives. The Combination Alternative begins at the MA/NH border with four lanes extending northerly approximately 4.3 miles (to north of Salem/Windham Town Line) for the southbound barrel and 7.3 miles for the northbound barrel (to just north of the Exit 3 Interchange). It then continues with three lanes northerly to the end of the project (approximately 15.5 miles and 12.5 miles for the southbound and northbound barrels, respectively).

Future Accommodations

For each of the Build Alternatives, space for a potential future light rail line is also being proposed as part of this project. This I-93 corridor rail line would extend into Massachusetts, either connected to the existing Manchester to Lawrence rail line or perhaps connected to a new line that would follow I-93 in MA to the Anderson Transportation Center in Woburn, MA. Space for a rail line would be reserved in NH for either option. In NH, the footprint being preserved for a potential rail line begins along the west side of I-93 at the MA/NH state line and continues northerly until just north of Exit 1 where the rail line would cross over the I-93 southbound barrel into the median and continue northerly inside the median, through Exit 5. North of Exit 5, the line would then be connected to the existing abandoned Manchester to Lawrence Branch to the west of I-93. This would provide the potential for a future connection to the Manchester Airport and/or downtown Manchester.

In addition, each of the Build Alternatives make allowances for the potential reactivation of rail service along the former Manchester-Lawrence Rail Corridor. Grade-separated crossings of the rail corridors are maintained so as to not preclude the opportunity for future rail service, either along the Manchester-Lawrence line or in the highway median, at some point in the future.

The I-93 typical cross section for the Build Alternatives includes provisions for three or four 12-foot wide general-use travel lanes, a 12-foot wide inside shoulder and a 12-foot wide outside shoulder in each direction. An additional 6-foot wide inside graded panel in each direction allows for flexibility during final design and an opportunity to accommodate the development of a potential future High Occupancy Vehicle (HOV) Lane with the Four-Lane Alternative. The minimum median width is approximately thirty-eight feet (south of Exit 1). In areas where space for a future rail line is preserved within the median, the median width varies between approximately 60 feet to 90 feet (**Figure 2.3-20**).

Three Lanes vs. Four Lanes

South of the Exit 1 Interchange in Salem, only a Four-Lane Alternative is proposed, and as such becomes a fundamental design component for the Three-Lane, the Four-Lane, or the Combination Alternative. It should be noted that, although the projected 2020 traffic volumes show a need to provide for five general-use lanes south of Exit 1, to meet the future year traffic demand (see Section 4.2.3 discussion), NHDOT's direction is to not construct more than four general-use travel lanes in one direction in New Hampshire. Constructing a four-lane section would provide a safer roadway section and immediate operational relief when completed. Improving and retaining the existing three-lane section south of Exit 1 was not considered practicable because the existing section is failing under today's traffic demand.

It should also be noted that until the timing and the implementation strategy for the widening of I-93 in Methuen and Andover from three-lanes to four-lanes in each direction is determined, the proposed eight-lanes in New Hampshire will transition,

using appropriate lanes tapers and informational signing, to match the existing six lanes at the MA/NH border. All of proposed widening for the proposed eight-lane section in New Hampshire would be constructed to accommodate the future connection to the eight lanes being considered in Massachusetts.

As part of the three Build Alternatives, optional design layouts were developed for the five interchange areas, local crossroads, and several sections of the mainline. At Exit 1 and Exit 2, two interchange options were developed for each location. At Exit 3 nine options were developed reflecting two mainline and two connecting road improvement options, configured with various interchange ramp layouts. In the Exit 4 area, two I-93 mainline alignment options were developed and at Exit 5, three interchange options were developed.

As a general rule, these options can be configured with any of the three Build Alternatives, which allows for an array of improvement choices, each having its own range of socio-economic and environmental impacts. During the development of the alternatives and options for this project, it was decided that the interchange and connecting road modifications would be constructed to be generally compatible with, and accommodate, both the Three-Lane and the Four-Lane Alternatives.

2.3.3.2 Description of Highway Segments

To allow a straightforward comparison of the various Build Alternatives and options, the 19.8-mile corridor was divided into six Segments (A through F; **Figure 2.3-23**).

Segment A is 1.0 mile in length and involves the area beginning at the MA/NH border and ending near the northbound rest area in Salem. Segment B is 0.9 miles long and includes the Cross Street overpass and the Exit 1 Interchange at Rockingham Park Boulevard in Salem. Segment C is 2.2 miles in length and includes the NH 38 (Lowell Road) underpass, the Exit 2 Interchange at NH 97 (Pelham Road), and the Brookdale Road overpass in Salem. Segment D is a 4.9-mile section located entirely in the Town of Windham and includes the NH 111A underpass, the Exit 3 Interchange with NH 111, and the North Lowell Road underpass. Segment E is 5.2 miles in length and involves a 2.0-mile section of I-93 in the Town of Derry and a 3.2-mile section of I-93 in the Town of Londonderry. The Derry section includes both the Fordway Extension and Kendall Pond Road underpasses while the Londonderry section includes the Exit 4 Interchange with NH 102, the Ash Street/Pillsbury Road overpass, and the Stonehenge Road underpass. The last section, Segment F, is 5.6 miles in length and includes a 2.7-mile section in the Town of Londonderry and a 2.9-mile section in the City of Manchester. In Segment F, the Londonderry section includes the Exit 5 Interchange with NH 28, and the Manchester section includes the I-93 bridges over Bodwell Road and Cohas Brook, and the southerly portion of the I-93/I-293/NH 101 Interchange.

2.3.3.3 Build Alternatives with Interchange Options

Segments A and B

Again, for each of the three primary Build Alternatives (the Four-Lane Alternative, the Three-Lane Alternative, and the Combination Alternative), the mainline for Segments A and B are the same, and include four general-use lanes along the northbound and southbound mainline sections.

Segment A

Beginning at the MA/NH border, Segment A is approximately 1.0 mile in length and ends approximately 0.3 mile south of the Cross Street overpass. This Segment also includes the existing northbound rest area (**Figure 2.3-24**). The proposed widening for the Segment is primarily controlled by the need to reduce impacts to Policy Brook and the Spicket River (primarily flood related issues for both) located immediately adjacent to the northbound barrel. To minimize these impacts, the northbound barrel generally holds the eastern edge and grade of the existing pavement such that the widening and associated re-grading does not encroach into the Spicket River floodway or the Policy Brook watercourse. The widening of the northbound barrel would primarily take place to the west, into the existing median. This Segment of I-93 is a transition area where, in addition to the highway widening for the proposed four northbound and southbound lanes, traffic management lanes are proposed to control and manage traffic entering and exiting I-93 at Exit 1 and the northbound rest area.

For the northbound barrel the existing three-lane section is widened to four-lanes beginning approximately 400 feet north of the Massachusetts/New Hampshire border. An auxiliary travel lane would be added adjacent to the mainline traffic approximately 0.2 mile north of the MA/NH border for approximately 0.3 mile to introduce a two-lane off-ramp to a two-lane collector-distributor (C/D) road. The C/D road functions as a separate parallel roadway (approx. 20-foot median separation from the mainline) that will improve overall traffic flow by isolating the through traffic on I-93 from the traffic entering and exiting the rest area, traffic exiting to the Exit 1 northbound off-ramp, and the weaving motion between the two. The existing rest area ramps will be connected to the C/D road and require some minor realignment and reconstruction (i.e., the northbound off-ramp involves approximately 200 feet, and the northbound on-ramp involves approximately 700 ft).

For the southbound traffic, Segment A primarily consists of four travel lanes and generally parallels the northbound barrel. Because the existing highway section in Massachusetts is currently three lanes, the proposed four-lane widening in New Hampshire would transition to the three southbound lanes in Massachusetts beginning approximately 1000 feet north of the Massachusetts/New Hampshire border. The southbound barrel is separated from the northbound barrel by a proposed concrete barrier and narrow median (approximately 38 feet in width) with all southbound widening occurring to the west.

MA / NH Four-Lane / Three-Lane Transition Option. An option to transition the proposed four-lane northbound and southbound highway section to the existing three-lane northbound and southbound sections in Massachusetts would be to extend the proposed four-lane section southerly to the I-93/MA 213 Interchange (**Figure 2.3-24**), where the additional highway travel lanes could be added as traffic from MA 213 enters onto I-93 northbound or eliminated as traffic exits from I-93 southbound to MA 213. The work would involve the reconstruction and widening of approximately 0.6 mile of I-93 in Massachusetts, primarily north of the MA 213 Interchange, and include the addition of a northbound and southbound lane, modifications to the MA 213 southbound off and northbound on-ramps, and the widening of the I-93 bridges over Hampshire Road and Harris Brook. The widening would take place predominantly to the west of the existing highway and likely impact floodplains and wetland. Extraordinary means such as retaining walls would be considered to minimize their impacts. These conceptual modifications and associated environmental impacts have been discussed separately with Massachusetts Officials.

Segment B

Segment B begins just north of the northbound rest area in Salem and extends approximately 0.9 mile generally following the existing grade of I-93 and ending 0.1 mile south of the NH 38/I-93 overpass in Salem (**Figure 2.3-24**). This Segment includes the Exit 1 Interchange with Rockingham Park Boulevard and the continuation of the northbound C/D road described in Segment A. The C/D road would allow traffic departing the rest area, that desires to access I-93 NB, to weave with traffic exiting I-93 northbound to the Exit 1 northbound off-ramp (clear of any of the I-93 through traffic) before merging onto I-93 NB. The C/D road would provide a connection to the existing (and proposed) two-lane Exit 1 northbound off-ramp and transition back to I-93 northbound to allow rest area traffic to access I-93 northbound.

Exit 1 (Rockingham Park Boulevard). The Exit 1 northbound on-ramp would retain a similar configuration to the existing ramp, however the ramp would be reconstructed and lengthened because of the necessary grade raise due to the longer southbound ramp-bridges over I-93. The acceleration lane for the northbound on-ramp is proposed to be lengthened, requiring the widening (by approximately 12 feet) of the existing bridge over South Policy Street. A retaining wall, approximately 10-feet high and 900 feet long, will also be required along the east side of the ramp to minimize impacts to Porcupine Brook and adjacent wetlands. For the southbound on- and off-ramps at Exit 1, there are two options. Both options generally preserve the same interchange (trumpet type) configuration with a one-lane ramp for southbound traffic exiting to Rockingham Park Boulevard and a two-lane ramp for traffic entering I-93 southbound from Rockingham Park Boulevard.

Exit 1 Southbound Ramps, On-line Option. The first option retains the existing substandard ramp geometry (existing off-ramp radius is only 180 feet/25 mph design) to minimize impacts to the adjacent wetlands (**Figure 2.3-24**). The southbound ramps

would be reconstructed along the existing alignment and new longer span bridges would be constructed over I-93 as necessary to gain the required horizontal and vertical clearances. The grades for the new ramp bridges would be raised approximately two feet because of the increased structure depth of the longer span bridges. With this option, substantial temporary widening of the southbound on-ramp and off-ramp would be required to maintain traffic during the bridge and ramp construction. In addition, the proposed southbound off-ramp bridge and approaches would be widened to accommodate two-lanes and to allow for one-lane of traffic in each direction during construction. The On-line option would reconstruct approximately 0.5 mile of the southbound off-ramp and 0.8 mile of the southbound on-ramp. The southbound on-ramp modifications include two 12-foot travel lanes, a 10-foot outside shoulder and a 4-foot inside shoulder. The southbound off-ramp modifications include one 12-foot travel lane, a 10-foot outside shoulder and a 4-foot inside shoulder.

Exit 1 Southbound Ramps, Off-line Option. A second option for the southbound ramps at Exit 1 would provide for an improvement to the existing geometry by reconstructing the ramps to minimum, but modern, highway standards (radius 260 feet/30 mph design) (**Figure 2.3-24**). The improved geometry would require shifting the ramps approximately 70 to 200 feet to the west. The wetland system adjacent to the existing ramps will be impacted by the off-line ramp shift. Similar to the On-line Option, new bridges over I-93 would be constructed as necessary to gain the required horizontal and vertical clearances. The grades for the new ramp bridges would be raised approximately two feet because of the increased structure depth of the longer span bridges. The new off-line ramps would not require any substantial temporary widening to maintain traffic during construction. However, the proposed southbound off-ramp bridge would be widened (similar to the On-line Option) to accommodate two-lanes, and to allow for one lane of traffic in each direction during construction. The Off-line Option would reconstruct approximately 0.9 mile of the southbound off-ramp and 0.6 mile of the southbound on-ramp. The southbound on-ramp modifications include two 12-foot travel lanes, a 10-foot outside shoulder and a 4-foot inside shoulder. The southbound off-ramp modification includes one 12-foot travel lane, a 10-foot outside shoulder, and a 4-foot inside shoulder.

Cross Street. The Cross Street bridge and its approaches will require reconstruction to accommodate the widening of I-93. Two options are being considered and they include an On-line Option and an Off-line Option. For both options, the new bridge would be constructed over I-93 as necessary to achieve the required horizontal and vertical clearances. The bridge grade would be raised approximately two feet to accommodate the longer span. The bridge span and abutment layout would provide the span length and clearance necessary to accommodate space for a potential light rail line passing under Cross Street on the west side of the southbound barrel.

Cross Street Bridge, On-line Option. The On-line Option replaces the existing bridge generally on its existing alignment and uses a temporary detour bridge, north of the existing bridge to maintain traffic during construction (**Figure 2.3-24**). The On-line

Option would reconstruct approximately 0.4 mile of Cross Street and its approaches and provide for two 12-foot travel lanes with 4-foot shoulders and a 5-foot sidewalk.

Cross Street Bridge, Off-line Option. The Off-line Option replaces the existing bridge with a new curved girder bridge approximately 75 feet to the north, and uses the existing bridge to maintain traffic during construction (**Figure 2.3-24**). The Off-line Option would reconstruct approximately 0.4 mile of Cross Street and its approaches and provide for two 12-foot lanes with 4-foot shoulders and a 5-foot sidewalk.

Segments C, D, E and F

General: Three vs. Four Lanes

For the remaining Segments C, D, E, and F north of Exit 1, the highway widening for the Three-Lane and the Four-Lane Alternatives are very similar except for the number of proposed general-use travel lanes associated with either the Three-Lane or the Four-Lane Alternative. The chief difference between these two alternatives is that the Three-Lane Alternative would have 24 feet less paved travel way (i.e., one 12-foot lane in each direction) than the Four-Lane Alternative. On the surface, the difference between the two roadway footprints would result in fewer impacts to the natural environment and the adjacent properties with the implementation of the Three-Lane Alternative. However, while this is true to a degree, one additional design element that requires consideration when evaluating the Alternatives is the overall constructability and the ability to safely maintain traffic during construction.

Because the Build Alternatives would involve widening and reconstructing the existing two-lane highway and bridges to either three or four lanes in each direction, and because the traffic currently experiences severe congestion with the existing two lanes, there is a need to provide sufficient highway width during construction to safely maintain a minimum two lanes of traffic in each direction. With the Four-Lane Alternative, traffic would be maintained on the existing two-lane highway while the roadway and/or bridges are widened to accommodate the two additional lanes. Once the new widening is complete, traffic would shift onto the two new lanes and the two existing highway lanes and bridges would then be reconstructed (**Figure 2.3-22**). The over-widening of the three-lane section required to maintain traffic during construction approximates the total width and impacts of the 4-lane section.

For the Three-Lane Alternative, which is being considered for the 17.9-mile section (Segments C, D, E, and F) north of Exit 1, traffic would remain on the existing two-lane section while the new third lane is constructed. However, to reconstruct the two existing highway lanes and bridges, additional widening on a temporary basis would be necessary to safely maintain two lanes of traffic during construction. The additional widening would include the width necessary to accommodate two travel lanes, shoulders and a space for traffic control barriers to safely maintain traffic during construction. Where the I-93 grades are raised to accommodate an increase in

bridge structure-depth due to the longer bridge spans, the width of the additional widening would increase proportionately to accommodate construction activities while maintaining two lanes of traffic (**Figure 2.3-22**).

Segment C

Segment C begins just north of the Exit 1 Interchange with Rockingham Park Boulevard, extends approximately 2.2 miles northerly through the Exit 2 Interchange with Pelham Road, and terminates at the Salem/Windham Town Line. This Segment includes the northbound and southbound I-93 bridges over NH 38 (Lowell Road), the Exit 2 Interchange at NH 97 (Pelham Road), and the Brookdale Road overpass.

The southerly layout for Segment C begins near the Exit 1 Interchange and extends approximately 1.1-miles to the Exit 2 Interchange. In this southerly section three preliminary highway mainline/rail accommodation concepts were developed and compared against each other to understand the relative engineering issues, and environmental and property impacts **(Figure 2.3-25.1)**. The primary issues of concern include potential impacts to Porcupine Brook, adjacent prime wetlands and the residential and industrial buildings in close proximity to the northbound (Trolley Lane) and southbound barrels (Fern Road). Concept 1 would construct a new widened northbound barrel to the east of the existing northbound barrel, the existing northbound barrel would then be available for a future rail line and the southbound barrel would be widened to the west. Concept 2 would widen the existing northbound barrel to the east and widen the existing southbound barrel to the west, providing for a future rail line within the existing median. Concept 3 would widen the existing northbound barrel to the east and widen the existing southbound barrel to the west, providing for a future rail line west of the widened southbound barrel. As identified in the *Rationale Report,* Concept 2, by observation, has the least impacts and would be carried forward and evaluated in more detail.

Concept 2 holds both the existing northbound and southbound median edges of pavement as a control and all of the highway widening for either the Three-Lane or the Four-Lane Alternative occurs to the east for the northbound barrel and to the west for the southbound barrel. Maintaining the existing median width as a control in this area serves two functions. First, it substantially reduces any highway widening impacts to Porcupine Brook and adjoining wetlands in the median. Second, it preserves an opportunity to provide space for a future rail line in the median.

The northerly section of Segment C begins just south of the Exit 2 Interchange and extends approximately 1.1 miles to the Salem/Windham Town line. This section involves the Exit 2 Interchange and the Brookdale Road bridge overpass in addition to the widening of the mainline section. The mainline alignment continues to hold the existing northbound and southbound median edges of pavement as a control through the Exit 2-Interchange area. The grade for the northbound and southbound

barrels would be raised approximately five feet to accommodate the new longer span bridges over the widened Pelham Road.

Just south of Brookdale Road, and extending to the Salem/Windham Town line, the existing easterly edge of pavement for the northbound barrel is widened approximately 4 feet to the east to accommodate a truck climbing lane while the rest of the widening is to the west. Widening to the west minimizes impacts to the South Shore Road residences adjacent to the northbound barrel and maintains the existing buffer (approximately 300 feet) between the northbound barrel and Canobie Lake.

NH 38 (Lowell Road). In the area of Lowell Road, the northbound and southbound barrels will be raised approximately two feet to gain the required vertical clearances for the new wider and longer bridges. The new bridges will be long enough to accommodate a future five-lane section for Lowell Road (**Figure 2.3-25.2**) (Lowell Road is not proposed to be widened as part of the proposed I-93 modifications). A temporary detour bridge and approaches would be built west of and immediately adjacent to the southbound barrel to maintain traffic while the new bridges are constructed. A retaining wall approximately 5 feet high and 330 feet long is proposed to minimize impacts to the proposed development driveway to Furniture World along the west side of the southbound barrel immediately north of NH 38.

Upon completion, the southerly detour embankment would be retained and serve as part of a sound wall which would extend parallel to the southbound barrel and reduce noise impacts for the Fern Road area homes. Adjacent to Lowell Road along the Exit 1 northbound on-ramp, a retaining wall approximately 20-feet high and 300 feet long is proposed to minimize impacts to Porcupine Brook along the east side of the northbound barrel.

Exit 2 Interchange (NH 97/Pelham Road). Three options were considered for the Exit 2 Interchange (**Figure 2.3-25.2**). The first or Diamond Interchange Option uses a standard type diamond interchange configuration with signals at both the northbound and southbound ramp intersections with Pelham Road. The second or Loop Option is similar to the first in that the northbound ramp layout is configured as a diamond interchange with signals at the intersection with Pelham Road while the southbound ramps are both configured as free-flow ramps with the Pelham Road. Vehicles traveling eastbound on Pelham Road utilize a slip-ramp whereas the westbound traffic uses a loop-ramp design to access I-93 southbound. The third or Roundabout Option (suggested in the Comment Letters received as part of the Pubic Hearing held in November 2002) involves a diamond interchange ramp configuration as with the first option, but differs by incorporating roundabout layouts at each of the ramp intersections with Pelham Road instead of signalized intersections. For all three options, the northbound ramps generally preserve the diamond-type configuration that exists today. The northbound ramps intersect Pelham Road opposite each other at either a signalized intersection or unsignalized roundabout intersection. The northbound on-ramp transitions into a truck-climbing

lane (12-foot lane with 4-foot shoulder, 0.8 mile long) for the long uphill grade (3 percent) of the northbound barrel as it extends north from the Exit 2 Interchange.

At the southbound ramps all three options eliminate the existing difficult weave area between the southbound on and off ramps. The Diamond Interchange Option would construct a new diamond configuration with signals at the southbound on and off-ramp intersection with Pelham Road, similar to the northbound ramps. The Loop Option would provide a loop ramp configuration for traffic traveling westbound on Pelham Road to I-93 southbound. The loop ramp would pass over Pelham Road on a separate structure adjacent to the southbound mainline and then merge into one lane with the eastbound Pelham Road on-ramp traffic before merging with the I-93 southbound mainline. Because of the free-flow operation the loop configuration, the need for a signalized intersection (required with the southbound diamond configuration) with the southbound on-ramps along Pelham Road is eliminated. However, with the loop options the southbound of-ramp is shifted opposite Keewaydin Drive to form a 4-way signalized intersection, and approximately 900 feet of Keewaydin Drive would be reconstructed and widened. This widening requires additional property impacts. The loop ramps in the NW quadrant of the interchange would also traverse across the existing wetland areas in the infield of the existing loop configuration. The Roundabout Option would construct a roundabout at the southbound on and off-ramp intersection with Pelham Road, similar to the northbound ramps for this option. For all three interchange options, a retaining wall approximately 15 feet high and 1000 feet long is proposed along the southbound off-ramp to reduce slope impacts to existing buildings and properties. To the south, for the loop configuration option only, a retaining wall approximately 13 feet high and 350 feet long is proposed along the southbound on-ramp to reduce slope impacts to the Holiday Inn parking lot.

Pelham Road. For all three of the Exit 2 Interchange options, Pelham Road would be reconstructed and widened. The work begins near the North Policy Street/ South Policy Street intersection, extends westerly approximately 0.6 miles, and ends at the Stiles Road/Manor Parkway intersection. The Pelham Road modifications would include two twelve-foot travel lanes in each direction with five-foot shoulders and a raised median, which becomes a left-turn lane at intersections where appropriate. A five-foot sidewalk on one or both sides of the road, depending on section of Pelham Road, is also proposed. Retaining walls for both options are proposed along Pelham Road to the west of the interchange area to minimize impacts to the adjacent businesses. The first, located on the north side of Pelham Road opposite Park West Village, is approximately 300 feet long and 5 feet high. The second is approximately 50 feet long and 3 feet high and is situated in front of the Butler Realty property on the south side of Pelham Road.

Pelham Road with the Diamond Interchange Option. The existing five-lane Pelham Road section (two through-lanes in each direction and a single left-turn lane in the median) at the South and North Policy Road intersection is proposed to be extended westerly to just east of the Exit 2 northbound ramps where the widening transitions to a

seven-lane section. Pelham Road would be widened to seven-lanes to accommodate two eastbound to northbound left-turn lanes and a single westbound to southbound left-turn lane, in addition to the two through-lanes in each direction. The seven-lane section transitions to five-lanes at the Keewaydin Drive intersection and then extends to the Stiles Road/Manor Road intersection. For the Diamond Option, five traffic signals will be required located at the following intersections with Pelham Road: Manor Parkway/Stiles Road, Keewaydin Drive, southbound ramps, northbound ramps, and North/South Policy Street (**Figure 2.3-25.2**).

Pelham Road with the Loop Interchange Option. As with the Diamond Option, the existing five-lane Pelham Road section is extended westerly to the Exit 2 Interchange. For this option, the widening for the westbound double left-turn lanes are extended to Keewaydin Drive before transitioning back to five-lanes and ending at the Stiles Road/Manor Road intersection. Four traffic signals for the Loop Option will be required at the following intersections with Pelham Road: Manor Parkway/Stiles Road, Keewaydin Drive/southbound ramps, northbound ramps, and North/South Policy Street. The Loop Option layout, when compared to the Diamond Option, will eliminate one signal by combining the southbound off-ramp intersection with Keewaydin Drive creating a four-way intersection (**Figure 2.3-25.2).**

Pelham Road with the Roundabout Interchange Option. The existing five-lane Pelham Road section (two through-lanes in each direction and a single left-turn lane in the median) at the South and North Policy Road intersection is proposed to be extended westerly to just east of the Exit 2 northbound ramps where the widening transitions to a two-lane roundabout at the northbound ramps. The widening continues westerly as a four-lane section with raised median to a two-lane roundabout with the southbound ramps. West of the southbound ramps roundabout, Pelham Road transitions to five-lanes at the Keewaydin Drive intersection and then extends to the Stiles Road/Manor Road intersection. For the Roundabout Option, two roundabouts at the ramp terminals and three traffic signals will be required located at the following intersections with Pelham Road: Manor Parkway/Stiles Road, Keewaydin Drive, and North/South Policy Street **(Figure 2.3-25.2)**.

Brookdale Road. Brookdale Road in Salem passes over I-93 approximately 0.7 miles north of the Exit 2 Interchange. Two options were developed, an Off-line option where a new bridge is constructed to the south of the existing bridge and an On-line option where the new bridge would be constructed along the alignment of the existing bridge with a temporary detour bridge to the south. For both options, the new bridge would be constructed over I-93 as necessary to achieve the required horizontal and vertical clearances and provide for two 4-foot lanes with 4-foot shoulders and a 5-foot sidewalk on the north side (**Figure 2.3-25.2**).

On-line Option. The On-line Brookdale Road option would reconstruct approximately 0.3 mile of Brookdale Road and its approaches and replace the existing bridge

generally on its existing alignment. A temporary detour bridge to the south would be necessary to maintain traffic during construction.

Off-line Option. The Off-line option would construct approximately 0.3 mile of Brookdale Road and approaches on new alignment. The new bridge would be located approximately 60 feet to the south of the existing. The existing bridge would be used to maintain traffic during construction of the new bridge.

Segment D

Segment D is located in the Town of Windham and begins at the Salem/Windham Town line, extends approximately 4.9 miles northerly through the Exit 3 Interchange with NH 111, and terminates at the Windham/Derry Town line (**Figures 2.3-26 through 2.3-31**). It should be noted that the Combination Alternative under consideration transitions from a Four-Lane Alternative to the Three-Lane Alternative in this segment. For the Combination Alternative in the northbound direction, the four-lane section extending from the MA/NH line to the south would transition to a three-lane section near the Windham Weigh Stations. For the Combination Alternative in the southbound direction, the three-lane section extends southerly from Manchester through the Exit 3 Interchange before merging with the proposed two-lane Exit 3 southbound on-ramp where the five-lane section merges to four lanes and extends southerly to the NH/MA border.

The major elements of this segment include the widening and/or realignment of the I-93 northbound and southbound mainline, the Exit 3 Interchange at NH 111 (Indian Rock Road), the northbound and southbound I-93 bridge replacements over NH 111A (Range Road), the northbound and southbound I-93 bridge widenings at North Lowell Road and minor modifications to the Windham Weigh Stations. In addition, there are nine Exit 3 Interchange options, which include two alignment options involving the I-93 mainline, two alignment options for NH 111 west of the Exit 3 Interchange, two options for the re-configuration of the southbound ramp, three options for the re-configuration of the northbound ramps, and an option to relocate a section of NH 111A.

I-93 Mainline. Within this segment, the portion of the mainline between the Salem/Windham Town Line through Exit 3 to just south of the weigh stations would be realigned to create one of two layout options for either the Three-Lane or the Four-Lane Alternative. The two options include the I-93 Northbound Shift Option and the I-93 Tight Shift Option and both relocate the northbound and southbound barrels into the median to varying degrees in the vicinity of the Exit 3 Interchange in order to address existing geometric deficiencies and increase separation between the successive northbound ramp terminal and NH 111A intersections. Another option was suggested following the November 2002 public hearing by private interests. This option would hold the existing alignment and widen each barrel of I-93 while maintaining as much of the existing median as possible to allow for private development. Elsewhere the widening generally involves holding the outside edges of the existing pavement for

both the northbound and southbound barrels with one exception. The exception involves a 1.4-mile section of the mainline, just north of the weigh stations, where the highway widening shifts from the median to the outside. In doing so, the widening matches into the existing bridges (southbound constructed in 1994, northbound constructed in 1998) over North Lowell Road (**Figures 2.3-26 through 2.3-31**).

I-93 Northbound Shift Option. The I-93 Northbound Shift Option begins just south of NH 111A and involves relocating a 0.9-mile section of the northbound barrel approximately 500 feet to the west into the existing median area (**Figures 2.3-26 and 2.3-27**). The relocation of the northbound barrel allows the proposed NH 111/Northbound ramp intersection to shift further away from the existing NH 111/NH 111A intersection. Currently the existing NH 111/Northbound ramps and the existing NH 111/ NH 111A intersections are close together (approximately 500 feet) creating operational problems for both intersections. The proposed layout provides for more separation (either 1,100 feet or 1,800 feet depending upon the northbound ramp option chosen) between the intersections. The relocated northbound barrel will generally follow the same three-percent maximum grade as the existing northbound barrel. A new longer span and higher bridge would carry the northbound barrel over the widened NH 111. The northbound bridge over NH 111A (re-constructed in 1994) would be replaced.

For this option, the modifications to the southbound barrel involve widening the existing highway toward the median including a 0.5-mile section centered over NH 111 where the southbound barrel is realigned easterly approximately 100 feet. The easterly shift of the southbound barrel allows for construction of a new I-93 southbound bridge over NH 111 while addressing the need to provide for two-lanes of traffic during construction. The existing southbound grade (five-percent) is retained. The southbound bridge over NH 111A would be replaced.

For the Northbound Shift Option, a park-and-ride lot is proposed to be constructed in the remaining median area between the northbound and southbound barrels south of NH 111. Access to the park-and-ride from NH 111 would be provided at a signalized intersection between the northbound and southbound ramp intersections with NH 111. (See Park-and-Ride discussion, Section 2.3.5.4)

I-93 Tight Shift Option. A second mainline option for the Exit 3 Interchange was developed in response to the Town of Windham's request to look at reducing the I-93 Exit 3-Interchange area footprint. This option, called the Tight Shift Option, realigns both the northbound and southbound barrels into the existing wide median (**Figures 2.3-28 through 2.3-30**). The southbound barrel is realigned approximately 150 feet east of the existing NH 111A overpass and approximately 300 feet to the east of the existing southbound barrel over NH 111 before transitioning back to the existing southbound barrel north and south of the interchange area. The grade for the southbound barrel is proposed to be raised nearly 25 feet above NH 111 in the Exit 3-Interchange area to flatten the existing downgrade from five-percent to approximately three-percent. The grade raise would improve the current

undesirable geometric combination of a steep downgrade with relatively sharp horizontal curvature along the southbound barrel.

The northbound barrel is proposed to be relocated adjacent to the new southbound barrel (approximately 90 feet is held in the median between the proposed northbound and southbound barrels to preserve space for a potential future rail line) beginning just north of the Brookdale Road bridge and extending northerly for approximately 2.2 miles. Similar to the Northbound Shift Option described previously, the Tight Shift Option allows the northbound ramps to be relocated away from the existing NH 111/ NH 111A signalized intersection to improve intersection operations. (The existing distance between the existing northbound off-ramp and the NH 111A signals is 500 feet while the distance between proposed signalized intersections for the relocated NH 111A and the northbound off-ramp is 1,200 feet). With the Tight Shift Option, approximately 1.9 miles of the existing northbound barrel is bypassed. Approximately 0.4 mile is reused for the development of a proposed park-and-ride access road and for the modification of the northbound on-ramps. The remaining 1.5 miles of the existing northbound barrel is proposed to be removed and re-graded, including a 0.2 mile section that is proposed to be part of a wetland mitigation package.

NH 111A (Range Road). As a result of input from the Town of Windham, the proposed park-and-ride access option shown in the DEIS was modified. The original access option was to construct an access road connecting at the unsignalized intersection between NH 111 and NH 111A. The revised design (**Figure 2.7-7**) relocates NH 111A away from its current intersection with NH 111 to separate local traffic from through and commercial traffic and give better access to remaining adjacent land for future development. The proposed layout involves constructing a 0.5 mile section of NH 111A on new alignment approximately 500 feet west of existing NH 111A. This new section of NH 111A connects to NH 111 at a signalized intersection approximately 600 feet west of the existing NH 111/NH 111A intersection. The 0.5 mile bypassed portion of existing NH 111A would remain as a local service road for the existing businesses and properties and access to West Shore Road. The existing NH 111/NH 111A signalized intersection would be reconfigured as an unsignalized intersection allowing for right-turn vehicles to enter and exit this local service road and left turn vehicles to only enter the local service road (left turn vehicles exiting the local service road would be prohibited). The westerly end of the local service road would connect to the relocated section of NH 111A at an unsignalized intersection.

For the Tight Shift Option, a park-and-ride lot is proposed to be constructed just east of the new realigned northbound barrel. Access to the park-and-ride lot would be from the relocated section of NH 111A (see Park-and-Ride discussion, Section 2.3.5.5).

NH 111 (Indian Rock Road). The modifications considered for NH 111 include two options involving the location of NH 111 west of I-93. East of I-93 northbound,

modifications to NH 111 involve reconstructing and widening NH 111 to five lanes (two 12-foot travel lanes in each direction with 10-foot shoulders and a raised median which becomes a left-turn lane at intersections where appropriate) beginning at the NH 111/NH 111A intersection and extending approximately 0.6 mile to near the I-93 southbound bridge over NH 111. The proposed NH 111 improvements for this project also include space to accommodate utilities and a sidewalk. The easterly modifications would connect to the NHDOT's five-lane Windham–Salem 10075 project (currently in design, with construction scheduled to start in 2003). The Windham-Salem project begins just east of the NH 111/NH 111A intersection in Windham and extends easterly approximately 3.0 miles into Salem.

West of the I-93 southbound bridge over NH 111, two options (the Relocation Option and the On-Line Option) were studied for NH 111.

NH 111 Relocation Option. The NH 111 Relocation Option involves modifications to a 1.2-mile section of NH 111 beginning near the I-93 southbound barrel and extending westerly and matching to existing NH 111 just before the Village Green shopping plaza signals (**Figures 2.3-27, 2.3-29 and 2.3-30**). Approximately 1.0 mile of this section would be constructed on a new NH 111 alignment approximately 450 feet to the north of existing NH 111. The relocation would minimize impacts to a number of businesses and properties adjacent to existing NH 111, although other businesses at each end of the relocation would require complete acquisition. The 0.5-mile bypassed portion of existing NH 111 would serve as a frontage road for the existing businesses and properties and connect to the relocated NH 111 at a signalized intersection opposite Wall Street. A turnaround, just east of the Castleton driveway would allow vehicles to reverse direction on the dead-ended portion of the bypassed section of NH 111. The layout for NH 111 west of I-93 could include extending the same five-lane section (six-lane section for the southbound diamond interchange configuration ramp before transitioning to five-lanes) as proposed for the easterly NH 111 modifications through the new Wall Street/Old NH 111 Connector intersection. The five-lanes would then transition to the existing 3-lane section (one travel-lane in each direction and a single painted median center turning lane) at the signalized intersection for the Village Green stores. An alternative width for relocated NH 111 would be to transition the 5-lane section required at the southbound ramp intersection down to a 3-lane section just west of the intersection. This section would then match into the 3-lane section that exists at the Wall Street intersection. The right-of-way width would be sufficient to widen this section of NH 111 in the future, when the additional lanes are required.

NH 111 On-Line Option. The NH 111 On-line Option involves modifications to a 1.2-mile section of NH 111 beginning near the I-93 southbound barrel and extending westerly through the Wall Street intersection and ending just before the Village Green shopping plaza signals (**Figures 2.3-26 and 2.3-28**). The On-line option would involve extending the five-lane section (six-lane section in the case of the southbound diamond interchange configuration before transitioning to five-lanes) proposed for NH 111 east of the southbound barrel. The five lanes would transition to three lanes

west of the Castleton Drive. A raised median island proposed through the interchange area and the southbound ramps would extend to Waters Edge Road precluding left turns to and from existing drives adjacent to the signalized intersection with the southbound ramps. The three-lane (one travel-lane in each direction and a single painted median center turning lane) section would then extend west through the Wall Street intersection to the existing three-lane section at the signalized intersection at the Village Green stores. The five-lane to three-lane layout would present operational problems due to congestion from NH 111 westbound traffic backing up into the interchange area prior to the design year of 2020. A five-lane layout from the southbound ramps to Wall Street was considered but not pursued as the widening would severely encroach upon every property along this section of NH 111 and adversely affect access to many of the properties (because the grades of the driveways would be made substantially steeper).

The three-lane layout would widen the existing pavement closer to the properties along both sides of NH 111. Retaining walls of varying heights and lengths would be required along the north side of the roadway to limit property impacts, and access to properties along the south side of NH 111 would be further compromised as the driveways and side roads would necessarily become steeper. Access to properties in general would be further compromised over time as traffic volumes continue to increase along NH 111.

Exit 3 Southbound Ramp Layouts. The existing southbound ramp configuration at Exit 3 involves a loop-ramp in the southwest quadrant for all southbound traffic getting off I-93 and an adjacent slip ramp for all southbound traffic getting onto I-93 from NH 111.

The proposed interchange modifications involve reconstructing and realigning the southbound ramps to reflect more modern highway standards. The southbound off-ramp is proposed to be reconfigured to a standard (albeit long) diamond type ramp layout. In all cases, the reconfigured southbound off-ramp begins approximately 0.7-mile north of Exit 3 to provide desirable ramp geometry, safe sight distance and a reasonable ramp-downgrade (six-percent maximum) for traffic exiting I-93 to NH 111 at a signalized intersection. For the proposed southbound on-ramp, the ramp layout would be developed out of the influence of the proposed NH 111 signals with the southbound off-ramp allowing the on-ramp to operate in a free-flow condition. To the west of the proposed southbound on-ramp modifications, the eastbound traffic is provided a separate right turn lane along NH 111 before entering the southbound on-ramp.

For the NH 111 westbound traffic that desires to travel south on I-93, there are two layouts under consideration.

The first layout provides free-flow movements, which can only be implemented with the NH 111 Relocation Option. The free-flow layout involves a single lane free-flow loop ramp located in the NW quadrant of the Exit 3 Interchange. The NH 111 westbound traffic would exit NH 111 in a separate right turn lane, loop around and

cross over NH 111 on a new structure adjacent to the new I-93 southbound mainline bridge over NH 111. This ramp traffic would merge with the NH 111 eastbound ramp traffic onto a two-lane on-ramp prior to merging with the I-93 southbound mainline through traffic (**Figures 2.3-27 and 2.3-30**).

The second layout for NH 111 westbound to I-93 southbound traffic uses a signalized double-left turn lane. This interchange configuration can be used for both the NH 111 Relocation Option and the NH 111 On-line Option. The layout involves providing a signalized intersection along NH 111 where both the southbound off and the southbound on-ramps are located opposite each other. To access the southbound ramp, the NH 111 westbound traffic would turn left from double-left turn lanes at a signalized intersection and merge to a single-lane ramp. This southbound on-ramp, and the southbound on-ramp for the NH 111 eastbound traffic, would then merge together onto a two-lane on-ramp and proceed southerly before merging with the I-93 southbound mainline through traffic (**Figures 2.3-26, 2.3-28 and 2.3-29**).

Exit 3 Northbound Ramp Layouts. The existing northbound ramp configuration involves a diamond ramp for northbound traffic getting off from I-93 and an adjacent loop-ramp for NH 111 traffic getting onto I-93 NB.

For both the Northbound Shift Option and the Tight Shift Option, the I-93 northbound traffic exiting to NH 111 eastbound or westbound would use a diamond type two-lane off-ramp configuration connecting with NH 111 at a signalized intersection. As described earlier, the relocation of the northbound barrel allows the proposed northbound off-ramp to shift further away from the existing NH 111/ NH 111A intersection creating a more desirable intersection separation and improved operations. Relative to the northbound on-ramp layouts, in all cases the northbound on-ramp transitions into a truck-climbing lane (12-foot lane w/4-foot shoulder, 0.8 mile long) for the long grade (3 percent) of the northbound barrel as it extends north from the Exit 3 Interchange.

For the Tight Shift Option, the NH 111 eastbound and westbound traffic would use a diamond type ramp configuration to access I-93 northbound. The layout involves providing a signalized intersection along NH 111 where both the northbound off and the northbound on-ramps are located opposite each other. For the NH 111 eastbound traffic, vehicles would turn left from a left-turn lane at the signalized intersection and access the northbound on-ramp. For the NH 111 westbound traffic, a separate right-turn lane and free-flow slip ramp is provided just east of the proposed signalized intersection, in the NE quadrant of the interchange. Both northbound on-ramps for the NH 111 eastbound and the westbound traffic merge together and proceed northerly in one lane (as noted above, a truck climbing lane) before merging with the I-93 northbound traffic (**Figures 2.3-28 through 2.3-30**).

With the Northbound Shift Option, there are two eastbound to northbound layouts for NH 111 traffic to travel northbound on I-93. The first layout is the same configuration as the Tight Shift diamond layout described above (**Figure 2.3-26**). The second layout

involves an on-ramp configured as a single lane free-flow loop ramp in the southeast quadrant of the interchange. The NH 111 eastbound traffic would exit NH 111 in a separate right turn lane, loop around and cross over NH 111 on a new structure adjacent to the new northbound I-93 mainline bridge over NH 111. With this layout, the NH 111 westbound traffic accessing the northbound on-ramp would use a free-flow slip ramp in the northeast quadrant of the interchange. Both of the northbound on-ramps are merged into one lane (as noted above, a truck climbing lane) just north of NH 111 before merging with the I-93 northbound mainline through traffic (**Figure 2.3-27**).

A third layout for the northbound ramps, which was developed as part of the Windham-Salem study completed in 1995, included a northbound to westbound flyover ramp as part of a similar Northbound Shift Option. As part of this I-93 study this layout was considered early-on, but dismissed. As identified in the *Rationale Report,* the other layouts evaluated provide satisfactory levels of service with fewer impacts.

Windham Northbound and Southbound Weigh Stations. The northbound and southbound Windham weigh stations are located approximately 1.4 miles north of the Exit 3 Interchange and were recently reconstructed in 1999. The proposed highway widening in all cases would occur away from the weigh stations and into the median area. Only minor modifications to the acceleration and deceleration lane transitions will be required to maintain access to the stations (**Figure 2.3-31**).

North Lowell Road. The northbound and southbound bridges over North Lowell Road were replaced with new structures in 1998 and 1994, respectively. The bridges were constructed as two-lane bridges and designed to accommodate additional widening for one or two future lanes on either side of the bridges while maintaining the necessary clearances. The proposed modifications for any alternative would be to widen the existing bridges to the outside (**Figure 2.3-31**).

Segment E

Segment E is located in the Towns of Derry and Londonderry and begins at the Windham/Derry town line to the south, extends approximately 5.2 miles northerly through the Exit 4 Interchange with NH 102, and terminates at the I-93 overpass at Stonehenge Road in Londonderry (**Figures 2.3-32 through 2.3-34**).

The major elements of this Segment include the widening and/or realignment of the I-93 northbound and southbound mainline, the re-alignment of the Exit 4 Interchange at NH 102 (Nashua Road), the northbound and southbound I-93 bridge widenings over Kendall Pond Road and Fordway Extension in Derry and Stonehenge Road in Londonderry, and the replacement and lengthening of the Ash Street/Pillsbury Road bridge over I-93.

I–93 Mainline. Beginning near the Windham/Derry Town line and extending north through Kendall Pond Road, the I-93 northbound and southbound widening transitions from a widening to the outside for both barrels to a westerly widening to avoid impacts to a Prime Wetland located along the east side of the northbound barrel approximately 0.3 miles south of Kendall Pond Road. Between Fordway Extension and Kendall Pond Road two options were considered for the southbound barrel. The first would hold the median edge of the southbound barrel and widen westerly. This option would require a retaining wall (20 to 30 feet high) approximately 2000 feet long in the median area because of the 20-25 ft. grade difference between the two barrels. The second option would shift the southbound barrel further westerly, on new alignment, approximately 90 feet. This shift would reduce the need for a retaining wall in the median, but would result in a larger ledge cut along the west side of I-93. This option would appear to be easier to construct with respect to maintenance of traffic (**Figure 2.3-32**). From Kendall Pond Road northerly approximately 3.4 miles to Stonehenge Road, the northerly end of Segment E, easterly and westerly widening options were developed for the northbound and southbound barrels.

Easterly Widening Option. The Easterly Widening Option was developed to retain the existing Exit 4 southbound interchange ramps in the NW quadrant in an effort to limit difficult and expensive construction that would otherwise be encountered due to the high rock and the inherent difficulty in reconstructing the ramps while maintaining traffic during construction. The Easterly Widening Option would retain the existing southbound ramps by holding the westerly edge of the existing I-93 southbound barrel with all widening of the southbound barrel and the construction of the northbound barrel occurring to the east. The easterly widening would eliminate impacts to the existing Exit 4 Park-and-Ride facility located immediately adjacent to the southbound off-ramp. North of the southbound off ramp, the widening continues to hold the westerly edge of the southbound barrel and eliminates highway impacts to the historic apple orchard property, that is eligible for the National Register. The northbound ramps shift to the east and are reconstructed and lengthened to accommodate the mainline shift and widening. The existing diamond configuration would be retained. This option shifts the I-93 northbound barrel closer to Wheeler Pond, however, no construction would be required in the pond. A retaining wall approximately ten-feet high and 950 feet long would be constructed along the easterly side of the northbound barrel to reduce impacts to the parking areas for the Londonderry Commerce Center and Stom Commercial Park. Near Stonehenge Road, the widening of I-93 transitions from an easterly widening to an outside widening for both the northbound and the southbound barrels (**Figure 2.3-33**).

Westerly Widening Option. The second option involves widening I-93 to the west. This alternative was developed to shift the widening away from Wheeler Pond area. This alternative would hold the easterly edge of the existing I-93 northbound barrel and maintain the widening of I-93 to the west. No construction would be required in the pond. The westerly shift will require the realignment and reconstruction of the existing southbound on and off-ramps in the NW quadrant of the interchange. The

layout would require substantial rock removal for the reconstruction of the southbound ramps. The realignment of the southbound ramps would impact the existing park-and-ride access road and parking area for approximately 900 feet of the access road and require reconstruction and development of replacement parking (20 spaces). Reconstruction and realignment of the southbound ramps will also create substantial traffic control issues while trying to maintain traffic during the removal of the high rock adjacent to traffic. The diamond configuration of the northbound ramps would be retained, but the ramps would be reconstructed and lengthened to accommodate the highway widening. North of the Exit 4-Interchange area, the westerly shift continues to hold the easterly edge of the northbound barrel north from the Exit 4-Interchange area. The historic Woodmont apple orchard property would also be impacted. Near Stonehenge Road, the widening of the I-93 mainline transitions from a westerly widening to an outside widening for both the northbound and the southbound barrels (**Figure 2.3-34**).

Exit 4 - NH 102 (Nashua Road). At Exit 4, the modifications include maintaining the same basic interchange configuration that exists today while widening NH 102, replacing the existing NH 102 bridge over I-93 and reconstructing and lengthening the ramps. The proposed revisions involve realigning approximately 0.6 mile of NH 102 and constructing a new bridge over I-93 approximately 120 feet south of the existing bridge. The proposed grade of NH 102 would be raised approximately 3 feet to accommodate the longer span bridge over the widened I-93 northbound and southbound barrels. The realignment would allow the use of the existing bridge to maintain traffic while the new bridge is completed. The new bridge would provide for a seven-lane section (two 12-foot travel lanes in the eastbound direction with 5-foot shoulders, 5-foot sidewalks and a raised median which becomes a double left-turn lane as appropriate). To the east of I-93, the seven-lane section along NH 102 is carried to the signalized intersection with the southbound ramps, transitions to five-lanes at the Burger King Drive, and matches to the existing three-lane section at Londonderry Road. To the west of I-93, the seven-lane section transitions to five-lanes near the signalized intersection with the southbound off-ramps and continues westerly matching the existing roadway section near the NH 102 eastbound on-ramp.

Fordway Extension. The northbound and southbound bridges over Fordway Extension were replaced with new structures in 1998. The bridges were constructed as three-lane bridges and designed to accommodate additional widening for one future lane on either side of the bridges while maintaining the necessary clearances. The proposed modifications for any of the Alternatives under consideration would be to widen each of the existing bridges to the west. No roadway modifications are anticipated for Fordway Extension (**Figure 2.3-32**).

Kendall Pond Road. The northbound and southbound bridges over Kendall Pond Road were replaced with new structures in 1998. These bridges were also constructed as three-lane bridges and designed to accommodate additional widening for one future lane on either side of the bridges while maintaining the necessary clearances. The proposed modifications for any of the Alternatives under consideration would be to

widen the existing bridges to the west. No roadway modifications are anticipated for Kendall Pond Road (**Figure 2.3-32**).

Ash Street/Pillsbury Road Bridge over I-93. The Ash Street/Pillsbury Road Bridge over I-93 is proposed to be replaced to accommodate the I-93 widening for four lanes and preserve a space in the median for future rail. Two options are under consideration.

On-line Option. The On-line option would reconstruct approximately 0.2 mile of Ash Street/Pillsbury Road and its approaches and replace the existing bridge generally on its existing alignment. The new bridge would have two 12-foot lanes, 5-foot shoulders and a 5-foot sidewalk. A temporary detour bridge to the south would be necessary to maintain traffic during construction (**Figure 2.3-33**).

Off-line Option. The Off-line option would construct approximately 0.5 mile of Ash Street/Pillsbury Road and approaches on new alignment to the south. The new bridge would be located approximately 50 feet to the south of the existing. The existing bridge would be used to maintain traffic during construction and removed after the traffic is shifted to the new structure. The new bridge would have two 12-foot lanes, 5-foot shoulders and a 5-foot sidewalk (**Figure 2.3-34**).

Stonehenge Road. The northbound and southbound bridges over Stonehenge Road were replaced with new structures in 1998. The bridges were constructed as two-lane bridges and designed to accommodate additional widening for one or two future lanes on either side of the bridges while maintaining the necessary clearances. The proposed modifications at Stonehenge Road for any of the Alternatives under consideration would be to widen the existing bridges to the outside. No roadway modifications are anticipated for Stonehenge Road (**Figures 2.3-33 and 2.3-34**).

Segment F

Segment F is located in the Town of Londonderry and the City of Manchester and begins at the Stonehenge Road overpass in Londonderry, extends approximately 5.6 miles northerly through the Exit 5 Interchange with NH 28, and terminates at the I-93/I-293/NH 101 Interchange in Manchester (**Figures 2.3-35 and 2.3-36**).

The major elements of this Segment include the widening and/or realignment of the I-93 northbound and southbound mainline, the Exit 5 Interchange at NH 28 (Rockingham Road), the northbound and southbound I-93 bridge replacements over the Manchester to Lawrence rail line (abandoned), the northbound and southbound I-93 bridge widenings at Bodwell Road and northbound bridge widening over Cohas Brook (southerly crossing). Also included are the proposed widenings for the northbound bridge over Cohas Brook (northerly crossing) and the I-293 northbound to westbound bridge over Cohas Brook.

I–93 Mainline. The mainline modifications for this section begin at Stonehenge Road, and extend northerly. Over the first mile, the I-93 northbound and southbound lanes

are widened to the outside to a point just south of the Exit 5 Interchange where all widening then shifts to the west to avoid impacts to a locally sensitive wetland and pond in the NE quadrant of the Exit 5 Interchange. The space reserved for the future rail line ends just north of the Exit 5 Interchange where the I-93 rail line would tie back into the existing abandoned Manchester to Lawrence rail line to the west. The grade for the northbound and southbound barrels would be raised approximately six feet to accommodate the new longer span bridges over the widened NH 28 (**Figure 2.3-35**).

For the northbound barrel extending from the Exit 5 Interchange northerly for approximately 2.4 miles, the widening would continue to hold the outside edge of the highway with all widening occurring into the median before transitioning into the Department's recently constructed Bodwell Road project. The I-93 northbound widening would match into the Bodwell Road project by adding width to the outside edge of the northbound barrel. In doing so, impacts to Cohas Brook and associated wetlands in the median area can be minimized. The Three-Lane or the Four-Lane Alternative northbound travel lanes transition to five northbound lanes south of the Bodwell Road bridge crossing. The five-lane section would be carried north to the I-93 NB/I-293 NB/NH 101 westbound split where two northbound lanes would diverge to the west and match into the existing two lanes for the I-293 NB/NH 101 westbound connection and three northbound lanes would continue northerly and match into the existing three I-93 northbound travel lanes (**Figure 2.3-36**).

The widening of the southbound barrel continues to remain toward the outside before transitioning into the current Bodwell Road project.

Similar to the northbound barrel, the I-93 southbound widening would transition into the recently constructed I-93/Bodwell Road by widening to the outside of the highway. Two southbound travel lanes from I-293 SB/NH 101 eastbound would merge with three travel lanes from I-93 southbound north of the Bodwell Road bridge crossing, and the five lanes would then be carried south over Bodwell Road before transitioning to four travel lanes. For the Three-Lane Alternative, the five-lanes would transition to a four-lane section and continue southerly for approximately 0.3 mile before transitioning to the Three-Lane Alternative (**Figure 2.3-36**).

Exit 5 Interchange (NH 28/Rockingham Road). There are four options proposed for the Exit 5 Interchange (**Figure 2.3-35**). Two options represent the same general diamond-type northbound/southbound signalized ramp configuration that exists today. A third option retains a diamond configuration for the southbound ramps and relocates the northbound ramps further to the south. The fourth option involves using roundabout layouts at the northbound and southbound ramp intersections with NH 28. All four of the interchange options reflect the same design elements for NH 28 west of the southbound ramps. The reconstructed southbound ramps would have the same general diamond layout as exists today, however they would be lengthened

and widened with additional turn lanes. The southbound ramps would intersect NH 28 opposite each other at either a signalized intersection or an unsignalized roundabout. To the west of the southbound ramps, NH 28 would be reconstructed and widened. The westerly modifications to NH 28 begin at the southbound ramps and extend westerly through the unsignalized intersection with Perkins Road and through the signalized intersection of NH 28 /Vista Ridge Drive and Symmes Drive. The improvements include two 12-foot travel lanes in each direction with five-foot shoulders with a combination of raised and painted median treatments, which allow for left-turns where appropriate. The five-lane section transitions to a three-lane section just west of the Symmes Drive intersection before transitioning to the existing two-lane section of NH 28. A 5-foot sidewalk on the north side of NH 28 is also proposed between Liberty Drive, east of the interchange, and Symmes Drive. The Symmes Drive approach to NH 28 would be modified and connect to a proposed park-and-ride lot on the north. The existing access into the Waste Management transfer station from NH 28 would be modified to right turn in only. A new full access connecting Waste Management to NH 28 will be provided via the proposed park-and-ride lot access road connecting to Symmes Drive.

During the course of the evaluation process for park-and-ride lots at Exit 5, five concepts were developed: two with access from Symmes Drive and one lot with access from Perkins Road; one lot with access from NH 28 in the southeast quadrant of the interchange; and one with access from Auburn Road (see Park-and-Ride Section 2.3.5.4 and **Figure 2.3-41**). With the Perkins Road conceptual park-and-ride lot (Option 3), approximately 0.4 mile of Perkins Road would be reconstructed and a section relocated westerly opposite Symmes Drive with a signalized intersection at NH 28 (**Figure 2.3-41)**.

To the east of I-93, three options were developed for NH 28 and the northbound ramps. The Options include:

NH 28 On-line and NH 28 Relocation Options. The widening modifications for both the On-line and Relocation Options for NH 28 are similar to the widening of NH 28 west of I-93 described above. The modifications to NH 28 for these options begin at the southbound ramps and extend easterly approximately 0.5 mile. The NH 28 widening with signalization at the ramp intersections includes two 12-foot travel lanes in each direction with 5-foot shoulders and a combination of raised and painted median treatments which allow for left-turns where appropriate (between the northbound and southbound diamond interchange ramps, NH 28 includes two through lanes and a single left-turn lane in each direction, a total of six lanes). The NH 28 widening with the roundabout layout at the ramp intersections includes two 12-foot travel lanes in each direction with 5-foot shoulders and a raised median island between the ramp intersections and a combination of painted or raised median treatments for left turns to the east of the northbound ramps, where appropriate. The five-lane section along NH 28 transitions to the existing two-lane section just east of Liberty Drive. A 5-foot sidewalk on the north side of NH 28 is also proposed between Liberty Drive and Symmes Drive. The Liberty Drive approach to NH 28

would be signalized. Access at the NH 28/Auburn Road intersection would accommodate right turns entering and exiting Auburn Road as well as left turns entering Auburn Road. Approximately 1,400 feet of Independence Drive would be reconstructed and its westerly intersection with Auburn Road realigned opposite a driveway into a newly constructed office development. Approximately 500 feet of Auburn Road would also be reconstructed and widened. The northbound diamond ramps would be lengthened and widened to provide for turning lanes at a signalized intersection with NH 28. For the On-line Option, the eastern edge and the existing curvature for NH 28 are held as controls with widening occurring primarily toward the west. Full drive access to the Sunoco Gas Station is relocated opposite the Liberty Drive intersection.

For the NH 28 Relocation Option, a section of NH 28 between the northbound Ramps and Liberty Drive is relocated to the west requiring acquisition of the Sunoco Gas Station property. A section of existing NH 28, remaining from the relocation, would be retained and dead-ended with access provided via a connection to Auburn Road. The primary difference between the On-line and the Relocation Option is somewhat improved geometry of this section of NH 28 and the required property acquisition for the Relocation Option. All other design elements are similar.

NH 28, Northbound Ramp Relocation Option. The third option evaluated for the northbound ramps is the northbound Ramp Relocation Option. This option shifts the existing northbound ramp intersections with NH 28 approximately 1000 ft. further to the south and opposite the Liberty Drive intersection. By combining the NH 28 northbound ramps and proposed Liberty Drive signal, one signal would be eliminated near the Exit 5-Interchange area. The layout would extend the NH 28 five-lane section easterly from the Symmes Drive intersection to the Liberty Drive intersection where a six-lane section (two 12-foot travel lanes in each direction and a double left-turn lane for the northbound on-ramp) is developed to accommodate the traffic operations. This option also reduces the pavement width directly under the I-93 overpass bridges from a six-lane section necessary with the On-line and the Relocation Options (two-travel lanes in each direction and one left-turn lane in each direction) to a five-lane section. The intersection of Auburn Road and Independence Drive would be modified to accommodate the change in travel patterns resulting from the Auburn Road/NH 28 intersection.

I-93 NB/SB Bridges over the Manchester to Lawrence Rail Line. The I-93 northbound and southbound bridges over the former Manchester to Lawrence line are proposed to be replaced. The northbound and southbound barrels will be raised approximately five feet to gain the required vertical clearances for the new wider and longer bridges to accommodate space for a future rail line (**Figure 2.3-35**).

Bodwell Road Bridges. The northbound and southbound bridges over Bodwell Road were recently reconstructed to accommodate four lanes (two through lanes and two auxiliary lanes for the I-293 ramps). For the widening of I-93, the proposed modifications to the Bodwell Road bridges would widen the existing bridges to the

outside to accommodate five lanes. No roadway modifications are anticipated for Bodwell Road (**Figure 2.3-36**).

Northbound Bridge over Cohas Brook (Southerly Crossing). The northbound bridge over Cohas Brook (southerly crossing) was reconstructed to accommodate four lanes (two through lanes and two auxiliary lanes for the I-293 ramps). The proposed modifications to the bridge would be to widen the existing bridge to the outside (**Figure 2.3-36**).

Northbound Bridge over Cohas Brook (Northerly Crossing). The I-93 northbound to I-293 westbound ramps over Cohas Brook will be retained. The I-93 northbound mainline box culvert at Cohas Brook will be lengthened toward the west to accommodate three travel lanes and 10-foot shoulders. The I-93 southbound mainline box culvert at Cohas Brook will be lengthened towards the west to accommodate three travel lanes and 10-foot shoulders. I-293 eastbound to I-93 southbound box culvert will be retained (**Figure 2.3-36**).

2.3.3.4 Corridor Bike Path

Facilities for bicycles originally included in the layout presented in the Draft EIS have been eliminated from further study. NHDOT recently completed a separate Bikeway Feasibility Study in March 2003 to identify alternative transportation corridors for pedestrian and bicycle travel between Salem and Concord, NH. The study included consideration of on-road shared shoulder alternatives along local roads, the I-93 corridor bike path presented in the DEIS (described below), and a rail trail alternative. The study recommended the development of a rail trail facility located along the abandoned Manchester-Lawrence railroad corridor. The Feasibility Study recommended that the I-93 bicycle path layout not be pursued. The NHDOT is continuing to work with regional and local officials to implement the Bikeway Feasibility Study recommendations.

For the I-93 Corridor Bike Path, a single off-road bike path option was developed for the corridor between Exit 2 and Exit 5. In doing so constructability and cost implications were considered, and the magnitude of property and resource impacts were assessed. The path as considered would be constructed adjacent to the I-93 corridor, within the proposed highway right-of-way and as part of widening I-93 from the existing two-lane highway in each direction to three- or four-lane highway in each direction.

The location of a bike path is controlled by the need to minimize property and resource impacts, the need to provide linkage to the existing local roads and regional bike system, and the ease of traveling through the highway interchange areas. Wherever practicable, the bike path was developed to follow along the edge of the improved I-93 highway in the area disturbed by the highway widening. The

proposed bike path connects each of the corridor park-and-ride lots beginning with the proposed Exit 2 lot in Salem, extending to the proposed Exit 3 lot in Windham and the existing Exit 4 lot in Londonderry, ending at the proposed Exit 5 Park-and-Ride lot in Londonderry, a distance in total of approximately 12 miles. The bike path parallels the northbound barrel, except between Fordway Extension and Pillsbury Road (Exit 4-Interchange area), and between Stonehenge Road and Rockingham Road (Exit 5-Interchange area), where it parallels the southbound barrel. Crossovers are proposed at existing side roads.

The path as proposed would be a 10-foot paved path with 2-foot gravel shoulders. Grades were kept to a minimum (<5 percent) wherever possible in an effort to maintain compliance with the Americans with Disabilities Act (ADA). The bike path would intersect at grade all side roads crossing over or under I-93, which would allow greater access to the path.

2.3.3.5 Summary and Conclusions

The evaluation of the Build Alternatives included consideration of a Three-Lane Alternative, the Four-Lane Alternative, and the Combination Alternative. All focused on widening the existing two-lane roadway to either three or four lanes in each direction. Existing interchange layouts were evaluated for possible modernization and reconstruction. No consideration was given to constructing new interchanges on new location, as part of this study to widen I-93. However, under separate study, Derry and Londonderry are doing an independent study for a potential Exit 4A just north of Exit 4. Environmental, socio-economic and engineering constraints were taken into account during the development of these alternatives with impacts to resources minimized as practicable. Within the I-93 mainline highway corridor, additional width was included to accommodate a potential future rail line and the potential for future HOV lanes. Accommodations were made to not preclude either future median mass transit alternatives or restoration of rail service along the abandoned Manchester-Lawrence rail corridor. In addition, the layout includes provisions for sound walls, where appropriate and drainage facilities as required for water quality control purposes.

The 19.8-mile corridor was split up into six segments (A through F) for evaluation purposes relative to the various options within each segment. A total of 19 options were developed along the length of the corridor. Each option was evaluated for both the Three- and Four-lane Alternatives. Though the Four-Lane Alternative has one additional lane in each direction, compared to the Three-Lane Alternative, additional temporary width would be required to construct the Three-Lane Alternative while maintaining two lanes of traffic in each direction, and will likely approximate, in some cases only temporarily, the impacts resulting from the Four-Lane Alternative.

All three of the highway widening alternatives considered (the Three-Lane, Four-Lane, and Combination Alternatives) were carried forward for further evaluation. There are only two segments (Segment C and Segment D) with options considered early in the design process that have not been carried forward. For Segment C, three mainline alignments in the area immediately north of the Lowell Road (NH38) crossing were evaluated. The three options were developed given the constraints involving wetlands east and west of the highway and Porcupine Brook meandering through the median between the north and southbound barrels of I-93. By observation, and based on input from the natural resource agencies, the concept developed has all widening take place outside the median, and in effect results in minimal impact to Porcupine Brook in the median. For Segment D, the 1995 Exit 3 Interchange concept developed as part of the Windham-Salem NH 111 project (10075), which included a northbound to westbound flyover off-ramp, has not been carried forward. The options evaluated in Segment D provide satisfactory levels of service with fewer impacts. The highway widening and interchange options carried forward, which were developed to accommodate all three of the mainline alternatives, are summarized, by segment, in the following paragraphs.

- In **Segment A**, the proposed mainline and collector distributor highway layouts are the same for all three alternatives. The layouts were developed with an understanding of highway needs and environmental constraints and reflect the least damaging practicable approach. For the Cross Street overpass, two options were carried forward. An On-Line Option, which would require building a separate detour bridge to maintain traffic during construction, and an Off-Line Option, which would be constructed adjacent to the existing bridge.

- In **Segment B**, Exit 1 northbound ramps are the same for all three alternatives. Two options were considered for the Exit 1 southbound ramps. The On-Line option rehabilitates and retains the existing substandard geometry constructed in the 1960's, and the Off-Line option improves the existing geometry by reconstructing the ramps to current minimum highway standards. Retaining the existing substandard geometry was considered due to the presence of wetlands within and adjacent to the interchange and the designation of those wetlands as prime wetlands, although the designation has since changed.

- **In Segment C**, Exit 2 northbound ramp configurations remain the same through this Segment for all three alternatives. Both of the proposed Exit 2 southbound ramp options would eliminate the existing difficult weave. The Diamond Option mirrors the diamond layout for the northbound ramps and requires a smaller footprint than the Loop Option. The Loop Option provides more of a free-flow operation for traffic accessing the mainline. Both options require widening Pelham Road to a maximum of either six-lanes and four signals with the Loop Option, or seven-lanes and five signals with the Diamond Option. The loop ramp layout requires one additional bridge over Pelham Road. The roundabout concept (developed in response to comments received at the Public Hearing held in November, 2002) for the northbound and southbound ramp intersections at

Pelham Road, has not been carried forward. The direct physical impact of the roundabout option is not appreciably different from the signalized intersection option. Although the operational review found that an acceptable level-of-service can be achieved using a two-lane roundabout design, NHDOT feels that at this time a roundabout layout is not consistent with the NHDOT's practice for design of freeway type interchanges.

In recent years there has been an emergence of interest in modern roundabouts in New Hampshire as well as other part of the United States. NHDOT has recently evaluated use of roundabouts in Keene, Plymouth, and Ossipee. Currently only two roundabouts (Nashua and Keene) have been constructed in New Hampshire. Although there are many benefits to roundabouts, their function varies depending on their size. Modern roundabouts can range in size from an inscribed circular diameter as small as 50 feet for mini-roundabouts to as much as 500 feet for large multi-lane roundabouts. Smaller roundabouts are best for traffic calming, while larger roundabouts serve to provide high vehicular capacity. Roundabouts operate most safely when their geometry forces traffic to enter and circulate at slow speeds. Horizontal curvature and narrow pavement widths are used to produce this reduced-speed environment. However, the capacity of roundabouts is negatively affected by these low-speed design elements. As the widths and radii of the entry and circulatory roadways are reduced, the capacity of the roundabout is also reduced.[9] As widths and radii increase, the throughput capacity and vehicle speeds increase. In other words, the type of roundabout must be consistent with the functional need and desire (traffic calming or capacity).

To be successful, the installation of a roundabout must meet the need (traffic calming or capacity), must meet the acceptance of the community and must be consistent with the long-term vision of the transportation system. At this important juncture between the Interstate system and the local road network a high capacity multilane roundabout is required to provide sufficient capacity at these intersections. The NHDOT held numerous Public Informational meetings on this project and did not receive any input from the communities reflecting a desire to consider roundabouts at the interchanges along I-93.

NHDOT feels that, in general introducing smaller-diameter, single-lane traffic calming type roundabouts first makes the most sense for New Hampshire to acclimate the public before moving ahead with the larger, high capacity roundabouts. While analysis shows the roundabout option could work from a traffic standpoint, NHDOT has concerns with public acceptance and public unfamiliarity, particularly along the Interstate system. For these reasons, the NHDOT does not believe that interchange roundabouts are the appropriate traffic control device for this location.

[9] A Policy on Geometric Design of Highway and Streets, AASHTO, 2001, 4th Edition.

Two options were developed for the Brookdale Road overpass. An On-Line Option, which would require building a separate detour bridge to maintain traffic during construction, and an Off-Line Option, which would construct a new bridge adjacent to the existing bridge.

- In **Segment D**, nine options were developed to evaluate and assess the merits and effectiveness of layouts based on variations of the I-93 mainline, NH 111, and the interchange ramp configurations connecting with NH 111.

I-93 Mainline. Two mainline options were developed for the Exit 3 Interchange area. The Northbound Shift option relocates the northbound barrel westerly into the median area with only minor alignment adjustments to the southbound barrel to facilitate construction. The Tight Shift Option, developed in response to the Town of Windham's desire to reduce the overall footprint of the Exit 3 Interchange area, relocates both the southbound and the northbound barrels into the median area. Both of the mainline options improve intersection operations by providing greater distance between the northbound ramps and the existing NH 111/NH 111A intersection. The alignment for the Tight Shift Option also improves the geometry and shifts the mainline highway away from both Canobie Lake and Cobbetts Pond and also aids in reducing the overall Exit 3 Interchange footprint. The Town of Windham also requested that consideration should be given to relocating NH111A westerly away from its current intersection with NH 111 and that this option should provide for access to the proposed park-and-ride facility, as well as access to existing and future development on adjoining land.

For the Northbound Shift Option, six optional Exit 3 Interchange layouts were developed in concert with the NH 111 reconstruction, while three interchange and NH 111 configuration layouts were developed for the Tight Shift Option.

An option suggested by private interests following the November 2002 Public Hearing, involved holding the existing alignment of each barrel and widening the highway to maintain the existing median for private development. This option has not been carried forward as it does not address the continued intersection operational concerns due to the proximity to the NH 111A intersection; promotes development and associated traffic concerns within the interchange; does not address existing geometric deficiencies; and provides no comparative environmental benefit.

Exit 3 Interchange Ramps. The choices for the Exit 3 Interchange ramps for either of the two mainline options include diamond type layouts utilizing signalized intersections with NH 111 or loop-ramp type layouts providing for free-flow movements between I-93 and NH 111 in some locations.

All I-93 southbound off-ramp layouts were configured as a diamond type ramps due to the difficulty in developing a practicable loop-ramp configuration considering the relatively steep grades and the close proximity of Cobbetts Pond. For NH 111 eastbound traffic, all southbound on-ramp layouts utilize a diamond type free-flow slip ramp. For westbound traffic on NH 111, two ramp configurations were developed. A signalized diamond layout and a free-flow loop layout. The loop ramp layout requires an additional bridge over NH 111.

The northbound ramp layouts are similar to the southbound options. All northbound off-ramp layouts utilize a diamond type ramp layout similar to what currently exists. All northbound on-ramp layouts for NH 111 westbound traffic traveling north onto I-93 utilize a diamond type free-flow slip ramp. For eastbound NH 111 traffic traveling onto I-93 northerly, two ramp configurations were developed. A signalized diamond ramp layout and a free-flow loop ramp layout. The loop ramp layout requires an additional bridge over NH 111.

NH 111. For NH 111 east of the southbound ramps, there is one alignment layout that essentially utilizes and widens NH 111 in the area of the existing highway. West of the Exit 3 Interchange, two NH 111 alignments were developed which involve either reconstructing NH 111 on-line or relocating NH 111 slightly to the north and bypassing the segment of NH 111 just west of I-93.

The On-Line maintains the alignment of the existing NH 111. The existing highway would be widened to five lanes in the vicinity of the Exit 3 ramps and then transition to a three-lane segment tying into the existing three-lane segment east of the Village Green Plaza. The On-Line Option, as proposed, would impact the frontage of a number of properties and accentuate problems relative to accessing adjacent properties due to the width of the highway, the effects of the geometry of intersecting driveways, and the heavy traffic volumes. Overtime such a layout would experience severe operational difficulties given the magnitude of the traffic volumes and the presence of numerous driveways along this segment of NH 111. Widening and extending the five-lane section westerly to meet future traffic demands was considered, but given the severity of the property impacts and the Town of Windham's concerns, this option was not pursued.

The Relocation Option relocates NH 111 approximately 450 feet to the north and allows existing NH 111 from Wall Street to the SB ramps to be bypassed. In doing so, the through traffic is moved away from the many intersecting local roads (6) and residential and commercial drives (13) that exist along NH 111 between Wall Street and the southbound ramps. In addition, the heavy traffic would be removed further away from Cobbetts Pond. Existing NH 111 would act as a frontage road under the Relocated Option, with access to relocated NH 111 via a signalized intersection with Wall Street.

- In **Segment E**, two options for the southbound barrel were considered in the area just south of Kendall Pond Road. The one option would hold the median edge of the existing southbound barrel and widen to the west. This option would require extensive retaining walls. The second option shifts the whole I-93 southbound barrel to the west, thereby eliminating the need for extensive retaining walls and at the same time be more conducive to construction relative to maintenance of traffic. For the mainline through Exit 4, two options were considered, that would widen I-93 either easterly or westerly. Both options maintain the same basic interchange configuration that exists at Exit 4 today. The configuration of the northbound ramps is the same for both options, while the level of construction required for the southbound ramps would differ depending on the option.

  The Easterly Widening Option holds the westerly edge of the southbound barrel with all widening accommodated towards the east. This option retains the existing southbound ramps and avoids impacts to the adjacent park-and-ride facility and the historic Woodmont apple orchard to the north. The Westerly Widening Option holds the easterly edge of the northbound barrel with all widening accommodated towards the west. This option reduces the widening adjacent to the Wheeler Pond area, but would require complete reconstruction of the southbound ramps, which would be both costly and difficult for traffic management during construction because of the substantial rock removal required. The Westerly Widening Option would impact the existing park-and-ride facility and the historic apple orchard. With either option the NH 102 bridge over I-93 would be replaced with a new bridge, to the south of existing bridge.

  Two options are considered for the Ash Street/Pillsbury Road bridge over I-93. An On-Line Option, which would require a detour bridge to maintain traffic during construction, and an Off-Line Option, which would construct a new bridge adjacent to the existing bridge.

- In **Segment F**, the proposed alignments for the mainline, NH 28 west of I-93, and for the Exit 5 southbound ramp configurations would remain the same for all three Build Alternatives. East of the Exit 5 Interchange, three options were developed for the northbound ramps and NH 28. Two options, the NH 28 On-Line and the NH 28 Relocation Options, essentially retain the existing northbound ramp diamond configuration and involve reconstructing NH 28 to the south, either on existing alignment or as part of a short westerly realignment of NH 28 to improve its curvature. [Both of these options included variations of the northbound and southbound ramp intersections with NH 28 to include either a signalized ramp layout or a roundabout configuration. The roundabout layout for Exit 5 as with the Exit 2 roundabout concept has not been carried forward. (See previous roundabout discussion for Segment C.)] The third option, the Northbound Ramp Relocation Option, involves relocating the northbound ramps to the south, opposite the Liberty Drive intersection. This option eliminates one traffic signal located along NH 28 in the interchange area.

In summary, all three of the highway widening alternatives considered, the Three-Lane, Four-Lane, and Combination Alternatives, were carried forward for more detailed evaluation along with the options listed above. Analysis and comparison of impacts to the natural and built environments, including consideration of cost, constructability, and applicability to meeting the project purpose and need, are required to evaluate the Three-Lane, Four-Lane or Combination Alternatives.

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2.3.4 Transportation Demand Management

Transportation Demand Management (TDM) encompasses a variety of strategies that are designed to change personal travel behavior to reduce the demand for automobile use and the need for highway capacity expansion. This is accomplished through measures that reduce the number or length of drive-alone trips or that move trips out of times of peak roadway congestion.

TDM measures focus on providing incentives (or disincentives) to drivers who drive alone to encourage them to change their travel behavior to ride-share or use another mode of travel. TDM measures include consideration of major infrastructure investments to provide and expand alternative modes of transportation such as HOV lanes, park-and-ride facilities, bus services, and rail service. (Bus and rail services are discussed separately below under Mode Alternatives.)

Another measure designed to reduce peak hour traffic flow on highways is ramp metering. Ramp metering discussed in Section 2.3.2.2 is actually a Transportation System Management (TSM) measure because its primary purpose is to maximize the efficient utilization of the existing highway system. It can also have the effect of encouraging ride-sharing and transit use, but it can cause traffic to divert to other routes and shift the locations of roadway congestion and delay.

2.3.4.1 Employer-Based Measures

TDM strategies are most effective in changing commuting behavior if they are implemented through employers. As a result, employers are frequently responsible for funding TDM programs, at least in part. This reliance on private funding differentiates TDM programs from more traditional transportation services and creates opportunities for public/private partnerships to address transportation issues.

Nationally, a large variety of TDM strategies have been adopted. The most commonly implemented strategies include:

- Programs that encourage the use of transit, such as on-site sale of transit passes, employer shuttles to transit stations, employer subsidies for transit use (including employer provided passes), and adequate parking at transit stations.

- Ride-matching programs and preferential parking at the work site for carpools and vanpools.
- Bicycle and pedestrian amenities such as bicycle storage, showers and lockers, and improved pathways and access.
- Commuter choice programs which equalize tax treatment of parking and transit benefits. Employers can provide parking "cash-out" to encourage use of alternative modes.
- Support programs for those who commute via alternate modes, such as on-site services (shopping, banking, and day care) and guaranteed ride home programs.
- Variable work arrangements and work hours such as telecommuting, flextime, and compressed work weeks.

Implementation of TDM programs may occur voluntarily or may be required through government regulations. The government also encourages TDM programs through financial incentive programs.

Implementation of voluntary TDM programs is frequently facilitated through ride-share brokerages or transportation management associations (TMAs). Both are public/private partnerships that design, market, and implement programs that support commuting alternatives and administer incentives to employees who use the alternatives. These organizations also collaborate with state and local governments, public agencies, and transit operators to increase the availability of transportation alternatives.

Although these organizations exist in a variety of sizes and operational structures, they generally use government support in combination with private funding, which is obtained through cash grants, member dues, fees for services, or in-kind contributions. Ride-share brokerages offer area-wide services, but also work with individual employers to implement TDM programs at individual work sites. TMAs are groups of employers that band together to address specific transportation issues in their area by implementing TDM measures for member employers.

Typically, both types of organizations work with employers to provide a variety of TDM programs including ride-matching, on-site transit pass sales, employer shuttles to transit, guaranteed ride home programs, parking management, flexible work hours, and telecommuting. In addition, these organizations offer technical assistance to employers, provide marketing materials, and sponsor promotional events to educate employees about their commuting options.

The majority of work-related travel along the I-93 corridor is to workplaces in Massachusetts. These include employers in downtown Boston, employers along the I-95 (Route 128) and I-495 circumferential highways around Boston, and employers

along I-93 between I-95 and the New Hampshire state line. Employer-based TDM measures that would impact the I-93 corridor in New Hampshire would need to be implemented largely in Massachusetts.

Massachusetts has a number of TMAs that provide a range of services to many New Hampshire residents who work along the I-93 corridor and in Boston. The Massachusetts TMAs that have the greatest likelihood of influencing travel on the I-93 corridor in the study area are:

- The River Road TMA in Andover
- Junction TMO (Transportation Management Organization) in the Ballardvale Street/Lowell Junction area of Andover and Wilmington
- The Artery Business Committee TMA in Boston
- Commuter Works/MASCO in Boston (Longwood Medical and Academic Area)
- The Inter-institutional TMA in Boston (Boston Medical Center)
- The Logan TMA at Logan Airport
- The Seaport TMA in South Boston
- The Charles River TMA in Cambridge
- The 128 Business Council TMA

2.3.4.2 Congestion Pricing

Congestion pricing is essentially a TDM strategy that provides a financial disincentive to driving alone during peak periods of travel.[10] Congestion pricing is based on the market–based concept that those who demand use of a facility should pay for the capacity required to supply an adequate level of service on the facility. This suggests that drivers, during the highest demand periods, would change their travel behavior in order to maximize their individual needs.

Congestion pricing involves charging a premium price for use of a transportation facility during periods of congestion. This could involve imposing a charge during peak periods for a facility that is otherwise free of charge or it could involve charging a higher fee during peak periods on an existing toll facility.

Congestion pricing serves to reduce overall roadway delays on a facility by:

- Diverting drivers to alternative routes of travel;
- Causing drivers to share a ride to reduce individual expenses:
- Changing time of travel to times of reduced or no congestion; and
- Increasing the cost of travel and eliminating some trips altogether.

[10] Implementing Effective Traffic Demand Management Measures: Inventory of Measures and Synthesis of Experience, prepared by Comsis Corporation and the Institute of Transportation Engineers, for the U.S. Department of Transportation, DOT-T-94-02, September, 1993, p. 1-1.

In addition to reduced delays, congestion pricing provides benefits by:

- Raising revenues to provide improved transit service and/or other alternatives to single occupant vehicles (SOVs);
- Raising revenues needed to maintain and improve the roadway system; and
- Reducing vehicle miles traveled (VMT) thereby reducing vehicular emissions.

The main disadvantages of congestion pricing include:

- Adverse impacts on low income and disadvantaged groups -- congestion pricing could be viewed as a regressive tax, in that it is not tied to a person's ability to pay the fee. It is widely believed that congestion pricing will have a greater impact on low income and disadvantaged persons.[11]

- Impacts of traffic diversions on local streets and other roadways that serve as alternative routes -- congestion pricing may adversely affect communities adjacent to priced corridors because drivers will divert to nearby routes to avoid the tolls.[12] In fact, route diversion, rather than time or mode diversion, will be the most likely effect of congestion pricing.

- Actual and perceived lack of convenient transportation options to tolled roadways -- congestion pricing and alternative modes go together. The Federal Transit Administration's (FTA) experience points out that a charge for the use of roadway space will not be publicly accepted unless a viable, visible, and well-publicized alternative mode of transportation is provided for the affected area and for affected users.[13] Again, if alternative modes are not available, many drivers have little choice but to take an alternate route, or pay the toll.

- Opposition by some commercial interests — congestion pricing represents an increased cost of doing business, which could adversely affect local businesses sending or receiving deliveries. In many cases, business and delivery schedules have already been adjusted as much as possible and further shifting away from peak periods would not be possible.

- Concern that revenues will not be used for the transportation purpose for which they were collected, or in the areas where they were collected — revenues hold one of the keys to the political and public success of congestion pricing.[14, 15] There are a number of options for the use of revenues and there may be concerns that over time, revenues would not be used as proposed. Particular concern focuses

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[11] Lari, Adeel Z. and Kenneth R. Buckeye, "Measuring Public Acceptability of Congestion Pricing Options in Minnesota," ITE 1996 Compendium of Technical Papers, p. 476.

[12] *Ibid.*, p. 476.

[13] Arrillaga, Bert, "U.S. Experience with Congestion Pricing," ITE Journal, December 1993, p. 42.

[14] Van Hattum, David, "Political and Institutional Issues in Congestion Relief Tolls--Report on a National Study," ITE Journal, October 1996, p. 47.

[15] Small, Kenneth, "Using the Revenues from Congestion Pricing," Transportation, Vol 19, p. 359-381.

on revenues being diverted to other facilities or areas where congestion pricing is not in place.

There are four general types of congestion pricing projects:

1. **Variable Toll Facilities for New Highways.** The easiest form of providing congestion pricing is by making it a part of a brand new highway facility that will serve as another corridor to an existing transportation system. In doing so, the facility can be completely modern, other routes will exist, and the toll charges can be easily justified as necessary to support the construction cost, as well as the maintenance cost of the new facility.

2. **Variable Toll Facilities on Existing Toll Highways.** The second easiest form of providing congestion pricing is to convert an existing toll facility from charging uniform tolls to charging variable tolls. If drivers are already accustomed to paying a toll, then the practice of varying the toll by time of day or by vehicle occupancy can be a logical next step. In doing so, the facility should be outfitted with electric toll collection equipment to ease congestion and delay at the tolls and provide additional incentive to participate in the automated program.

3. **Variable Toll Facilities on Existing Non-Toll Highways.** A third way of providing congestion pricing is to convert a non-toll facility to a variable toll facility. Such a conversion is difficult to accomplish. Toll facilities need to be constructed, not only at the terminal of the highway facility, but also at the interchange locations where traffic is entering or exiting the highway. To address the capacity needs through the toll access, additional highway widening is required with further impact to the environment and surrounding properties. Electronic toll collection should be incorporated to minimize delays as much as possible. It should also be noted that the ability to place tolls on interstate highways that currently do not have tolls is limited by federal law. Such toll initiatives must be carried out under the auspices of specific available FHWA programs, following approval of application.

4. **High Occupancy Free/Others Tolled (HOT) Lanes.**[16] A fourth means of congestion pricing involves constructing a barrier-separated high occupancy vehicle (HOV) system (physically separated HOV lanes with individual on and off-ramps independent of general purpose lanes and interchange ramps) and making available, for a price, the use of the HOV facility by single occupancy vehicles. High occupancy vehicles (HOVs) would travel in the HOV lane for free, but the single occupancy vehicles (SOVs) would pay a toll, with the cost depending on the congestion in the general purpose lanes. Such HOV facilities are known as HOT lanes. The benefit of such a facility is that the ridership in the facility can be maximized by varying the toll cost and thus the incentive/

[16] "HOT Lane" is a recent term devised by economists at the University of California-Irvine and the Reason Foundation.

disincentive to SOV motorists to use the HOT lanes. The drawback of such a facility is that the HOT system is expensive as it is separate from, and essentially independent of, the general purpose lane system; the facility requires a toll collection component which introduces additional costs and results in some delay that would otherwise not exist for HOVs; and the facility is perceived to cater to the wealthy who can more readily afford to pay this toll.

A variation of this fourth type of congestion pricing was implemented by the NHDOT along the F.E. Everett Turnpike in Bedford, NH in the mid-1990s. The initiative involved allowing vehicles with three or more people to not have to pay a toll, and as such, encourage HOV ridership. After two years, the project was discontinued due to limited success in reducing the volume of single occupancy vehicles (SOV).

The potential success of congestion pricing depends on the extent of congestion, the capacity and availability of alternative routes and modes, and the type of project employed. If congestion is already spread over several hours of the day, rather than concentrated in discrete, short time periods, then congestion pricing may not be very effective. Motorists may not see the benefit from shifting to another time period if congestion is still present. If reasonable alternative modes of travel are not available, then motorists are most likely to divert to an alternative, and possibly inappropriate, route near the priced facility.

If the system to be fitted with congestion pricing is a toll facility, public acceptance is likely to be more forthcoming. Infrastructure costs would be less and thus more palatable as well. If the system is a non-toll facility, then necessary infrastructure for congestion pricing will be substantially more expensive both in terms of construction as well as environmental and property costs, and public acceptance is likely to be more difficult to obtain. To incorporate congestion pricing through the use of a HOV system, infrastructure costs (as well as environmental and property impacts) are substantial, and public perception that the system benefits the wealthy calls into question the merits of such an arrangement.

2.3.4.3 Intelligent Transportation Systems (ITS)

Intelligent Transportation Systems are often used in support of Transportation Demand Management (TDM). In essence ITS enhance communication between the user and the infrastructure providing the TDM measure. Such ITS technologies or strategies were previously discussed in Section 2.3.2.4 and can be used to manage traffic/travel demand on the I-93 corridor before, during, and after construction. NHDOT is proceeding, through a Statewide ITS consultant, to develop the detailed tactical implementation of these ITS technologies within the corridor based on the strategic regional and statewide ITS architecture. NHDOT will be considering in more detail the following elements at the appropriate stages:

Pre-Construction

Develop and implement appropriate communication technologies along I-93 corridor to collect and analyze data from the sensors, and disseminate information.

Install pole mounted non-intrusive traffic detectors along I-93 (one between each interchange) from Massachusetts State Line to I-93/I-293 split to monitor traffic and provide real-time update on traffic delays to motorists along the corridors. These traffic detectors can also be used to detect incidents. These non-intrusive detectors can easily be moved during construction.

Install Portable Dynamic Message Signs at key locations as discussed in Section 2.3.2.4.2 to provide travelers real time information on traffic delays, detours, and incidents along the I-93 corridor.

Install cameras at key locations along I-93 (from Massachusetts State line to Exit 5) to monitor traffic and detect incidents. These cameras can be mounted on the same pole as the traffic detectors and relocated during construction. Also, images from these cameras can be displayed on the internet so that motorists, TV stations, and radio stations can access the information via web sites.

Install Road Weather Information System (RWIS) at two key locations as discussed in Section 2.3.2.4.2 along the I-93 corridor. These two sites will form part of a regional network of stations giving early warning of adverse weather. Install only atmospheric sensors prior to construction at these sites. Pavement sensors can be installed once construction is complete.

Install AM or Low Power FM (LPFM) sites along I-93 corridor to provide information to motorists as discussed in Section 2.3.2.4.2. These Highway Advisory Radios can be used to provide enhanced traveler information as well as promote tourism.

Promote public/private partnerships with NHDOT, State Police, TV stations, and radio stations to share information on traffic situations along I-93 corridor and provide information to the public in a timely manner.

Promote use of the 511 Travel Information Number, which is available statewide in New Hampshire to provide travelers with the information they need to make better-informed travel decisions. When travelers become aware of current or forecast weather and road conditions, traffic incidents or delays, they may choose to travel at other times, by other means, or not at all.

Promote use of alternate modes of transportation, such as ride-share and transit. Multi-Modal Traveler Information Systems take an extra step beyond the highway-based systems described above. The 511 Travel Information Number can be enhanced to provide real-time transit schedules and schedule adherence, availability

of parking spaces in the park-and-ride lots, as well as highway congestion information. This will be important as the new proposed park-and-ride facilities and expanded corridor bus service become operational at the outset of the mainline reconstruction. Alternative mode choices can be properly evaluated by travelers before they become tied up in traffic delays. Trio's proposed statewide enhancements (Section 2.3.2.4.1) envision regional, multi-modal additions to the advanced traveler information systems currently being deployed. Substantial benefits can be expected in support of TDM strategies along I-93 once these multi-modal enhancements become operational.

Construction

Maintain ITS systems deployed pre-construction to manage traffic and provide timely information to travelers. Relocate the non-intrusive traffic detectors, cameras, and portable dynamic message signs as appropriate to accommodate construction.

Implement Smart Work Zone technologies to monitor traffic through construction zones and also provide information to travelers, TV, and radio stations.

Provide travel information through 511, AM, LPFM, and dynamic message signs.

Install infrastructure for future, permanent post-construction ITS applications.

Promote use of alternate modes of transportation, such as ride-share, and transit.

Post-Construction

Expand ITS Technologies as appropriate.

Install permanent non-intrusive traffic detectors, cameras, and dynamic message signs.

Install pavement sensors at the RWIS sites to detect pavement temperatures and conditions.

Provide travel information through 511, AM, LPFM, and dynamic message signs. Expand travel information services by providing information to motorists using in-vehicle technologies, such as pagers and cell phones.

Expand use of alternative modes. Online Scheduling and Reservations make it easier for travelers to use alternative modes of transportation by providing online tools or other electronic means for making reservations, obtaining schedules, paying fares, etc. This helps support mode switching at congested periods by reducing barriers to transit use, such as exact change requirements or general unfamiliarity with transit payment systems.

Electronic Fare Payment and Smart Cards offer similar advantages to travelers during the actual journey. New Hampshire is already investing in electronic payment system technologies at its highway toll plazas, due to come on line within the next two years. ITS can also provide broader electronic fare payment systems for transit and parking which can help support park-and-ride or public transit incentives.

2.3.4.4 Summary and Conclusions

In terms of I-93, the TDM measures with the greatest probability of success are those sponsored by employers. Congestion pricing is not reasonable because I-93 currently experiences peak periods of congestion of approximately three hours in length in both the morning and the evening. This extension of peak hour volumes to additional hours before or after the real hour, commonly referred to as "peak period spreading," has already occurred to a great extent, and disincentives to shift demand from the peak hour into adjacent hours will likely be unacceptable. Instead congestion pricing is likely to be perceived as a solution that does not address congestion, but simply levies a tax on those who must use the facility. Lastly, as a non-toll facility, public acceptance of making I-93 a toll facility would be difficult at best. Where toll facilities exist in New Hampshire, there is considerable public sentiment to eliminate their toll status. Additional impacts associated with toll facilities would be problematic. Similarly, HOT lanes are considered to be questionable in this instance particularly in light of the findings relative to the lack of HOV lane usage. ITS technologies will be incorporated into the overall improvements to I-93 to better manage traffic/travel demand before, during, and after construction.

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2.3.5 Mode Alternatives

For the analysis of potential improvements for I-93 between Salem and Manchester, an evaluation of transportation modes other than personal passenger vehicles in general-purpose highway travel lanes was conducted. These alternative modes included rail services, bus services, and HOV lanes. The objective for analyzing these other modes was to understand how they may complement and minimize the need for highway improvements.

This section describes the individual HOV, rail, and bus modes considered. It also reviews the methodology used to project rail, bus and HOV ridership, and presents the results of the analysis of potential ridership for the various modes.

The mode options that were analyzed include four rail options, two HOV lane options, and two bus options. Following establishment of parameters describing capabilities and limits of each option, the mode options were tested with varying assumptions about the capacity of I-93, including no-widening (i.e., no increase in

existing capacity), widening to three lanes in each direction, and widening to four lanes in each direction. All analyses included the assumption that the extension of commuter rail service from Lowell to Nashua is operational.

The mode options analyzed were chosen based on technology, financing, and infrastructure that are available today or are plausibly feasible. The intent was to test the ridership potential of alternative modes under favorable, but realistic conditions. The parameters used to define the options did not necessarily limit the capacity of the various options. For example, sufficient parking was assumed at each bus or rail station to accommodate all potential demand at the station. Similarly, a sufficient number of cars per train or buses were assumed to be available to satisfy projected demand.

Based on the preliminary analysis results, those mode options deemed feasible and practicable were combined with each other and various highway lane configurations (i.e., two, three, or four general use lanes in each direction). Fourteen mode combinations were identified to test the potential interaction between rail, bus, HOV and highway options and to determine how the ridership generated by these different combinations of mode options might influence the need for highway improvements. Section 2.3.5.5 presents projections of ridership for these combinations of other modes and highway widening options.

2.3.5.1 High Occupancy Vehicle (HOV) Lanes

HOV facilities provide lanes dedicated to vehicles carrying more than one person. The number of people required per vehicle and the time periods the lanes are so dedicated are dependent on the demand for the lanes. To be successful, HOV lanes must not be congested or there will be little incentive for drivers of single occupancy vehicles (SOV) to consider ride-sharing or bus services. In addition, the HOV lane must not be under-utilized, or motorists in general use lanes will question the merit of having HOV lanes. Possible HOV lane configurations include concurrent flow lanes and a single exclusive reversible (contra-flow) lane.

Two I-93 HOV lane options were preliminarily developed. The parameters and assumptions defining these options were:

1. One HOV lane in each direction on I-93 in New Hampshire from north of Exit 5 to the New Hampshire/Massachusetts state line. Access/egress would not be provided at either Exit 1 or 2 due to the proximity of the interchanges to each other and to the state line. Vehicles would be allowed to access/egress at all other exits.

   The geometric configuration of the lane was not a factor in the projection of ridership, but for the purposes of analyzing engineering and environmental

impacts, a concurrent flow lane adjacent to the general purpose lanes was assumed. The cross section included a 14-foot inside enforcement shoulder, a 12-foot HOV lane, a four-foot painted buffer, two or three 12-foot general purpose lanes, and an outside shoulder lane.

2. One HOV lane in each direction on I-93 from north of Exit 5 in New Hampshire to I-95 (Route 128) or the Woburn Interchange in Massachusetts. This scenario assumed that vehicles can access/egress the HOV lane at each New Hampshire interchange. The roadway cross section would be the same as for the first alternative and include a concurrent flow lane adjacent to two or three general purpose lanes.

2.3.5.2 Passenger Rail Service

Mode Options developed for the I-93 Salem – Manchester corridor included four rail alternatives along three basic rail alignments (see *Rail Alternatives Evaluation Report*, VHB, November 13, 2000). These rail alternatives were primarily focused on providing commuter service to Boston, MA thereby relieving auto congestion along the I-93 highway corridor during peak periods **(Figure 2.3-37)**. The alternatives developed included commuter rail service along the New Hampshire Main Line (West Rail Corridor from Manchester to Lowell, MA via Bedford, Merrimack and Nashua); commuter rail service along the Manchester and Lawrence Branch (East Rail Corridor from Manchester to Lawrence, MA) with two optional alignments near the Manchester Airport (i.e., tunnel and relocation); and two light rail services along the I-93 highway right-of-way beginning near Exit 5 or the Manchester Airport, and continuing along I-93 south of Exit 1, where it would connect either to Lawrence, MA (I-93 Basic Rail Corridor) or to the Anderson Transportation Center in Woburn, MA (I-93 Enhanced Rail Corridor). The *Rail Alternatives Evaluation Report* examined a number of different parameters associated with the implementation of rail service alternatives and Table 2.3-1 summarizes these parameters.

Each of the rail alternatives is described below.

East Rail Corridor (Manchester–Lawrence Line)

The East Rail Corridor principally follows the Manchester and Lawrence Branch (M&L), which is for the most part, an abandoned 28-mile rail line **(Figure 2.3-37)** that runs north-south from Manchester, NH to Lawrence, MA. The M&L branches from the New Hampshire Main Line (West Rail Corridor) in the Manchester Freight Yard, which is just south of the site of the former Manchester Station (near Commercial Street). From there, the line runs south toward Manchester Airport. In the area of the airport, two options were considered for this corridor, due to the recent extension of Runway 6-24 across the railroad right-of-way. One option (Option 1) would be to

construct a tunnel (with the tunnel assumed to be able to accommodate double tracks, clearance for double stack freight cars, very flat grades, approximately 15 feet of cover and poor foundation materials) underneath the runway within the former railroad right-of-way. With this option, service to the airport could be provided by constructing a rail station near the airport; however, some type of shuttle service would be needed to link rail and airport users. The other option (Option 2) would be to relocate the rail line around the airport creating a new railroad right-of-way. Service to the airport with this option could be provided with a shuttle bus

Table 2.3-1
Summary of Rail Alternatives

Evaluation Parameter	West Rail Corridor (Nashua to Manchester)	East Rail Corridor w/Tunnel Option	East Rail Corridor w/Relocation Option	I-93 Rail Corridor (Basic)
Service Characteristics				
Route Length (Miles)	18.8	27.8	27.8	22.9
New Stations	3	4	3	4
Average Peak Direction Travel Time (Minutes)	83	94[1]	94[1]	83[1]
Type of Service	Through	Shuttle	Shuttle	Shuttle
Annual Trips	294,270	462,570	462,570	453,390
Locomotives/Coaches (Moderate)	6/42	3/9	3/9	0/9[3]
Annual Train Miles (Moderate)	96,900	129,900	129,900	98,300
Infrastructure				
Grade Crossings	20	42	49	11
Undergrade Structures	18	16	16	21
Moderate Scenario Costs				
Infrastructure ($m)[2]	$51.7	$172.9[4]	$97.1	$176.6
Equipment ($m)	$79.9	$24.1	$24.1	$36.7
Annual Operating ($m)	$4.5	$3.6	$3.6	$2.7
Total Annual Cost ($m)	$15.8	$19.1	$13.4	$19.6
Annual Revenues ($m)	$0.9	$0.3	$0.3	$0.6
Net Annual ($m)	$14.9	$18.8	$13.1	$19.0
Cost per Trip ($)	$51	$41	$28	$42
Cost per New Transit Trip ($)	$96	$83	$58	$80

1 Includes 5 minute average transfer time during peak period in predominant direction of travel. Off-peak and reverse peak transfer times higher.
2 Costs do not include real estate requirements
3 I-93 Rail Corridor utilizes a light rail system with self-propelled vehicles.
4 Note change, see Response #11 to letter P-1 (Volume 3).

connection to the airport. For both options, after passing by the Airport the rail line would continue south through Londonderry, Derry, Windham and Salem, east of I-93, to Lawrence, Massachusetts where it would connect to the Massachusetts Bay Transportation Authority's (MBTA) Haverhill Line.

A majority of the M&L rail corridor in New Hampshire is owned by the State. Some portions have been sold to towns or private land owners. A short portion of the line in Salem is owned by Guilford Transportation Industries (GTI) through the Boston & Maine Corporation. GTI has fled for abandonment of freight service north of Lawrence. In Massachusetts, the line is owned by the MBTA and GTI has freight rights.

The East Rail Corridor service would be a commuter rail shuttle service between Manchester and Lawrence with intermediate stations located near I-93 Exit 5 in Londonderry, and I-93 Exit 1 in Salem. Standard commuter rail equipment would be used for the service between Manchester and Lawrence. At the existing MBTA Lawrence Station, passengers would transfer to commuter rail trains on the Haverhill Line and continue south through Andover and on to Boston. Total travel time between Manchester and Boston would average 94 minutes. The service assumes that the MBTA trains would have sufficient capacity to accommodate the New Hampshire riders.

The rail service alternative has been developed as a shuttle instead of through service primarily due to the lack of capacity on the MBTA's Haverhill Line. There is currently a 12-mile segment of single-track railroad between Andover and Reading, which limits the number of trains the MBTA can operate north of Reading to Lawrence and Haverhill. Approximately half of the existing weekday Haverhill Line service terminates at Reading because of the capacity constraint. Therefore, it was assumed that any new service on the M&L would terminate at Lawrence requiring the transfer.

To institute rail shuttle service along the East Rail Corridor between Manchester and Lawrence would require capital improvements through the reconstruction of most of the existing track structure (rail, ties, ballast, sub-grade), bridges, grade crossings, and signal and communications system. Additionally, depending upon the specific rail alignment taken near Manchester Airport, a 820-foot rail tunnel under the runway or a 5-mile relocation of the rail corridor around the runway on a new alignment would be required. The East Rail Corridor infrastructure cost estimates associated with tunnel option or the relocation option are $172.9 M ($6.3 million per mile) and $97.1 M ($3.6 million per mile), respectively. These cost estimates do not include real estate or environmental mitigation.

Equipment required for the service would vary depending on the amount of service provided. For both options using this corridor, three service levels were considered. The high level of service includes 12 weekday and 4 weekend roundtrips. The moderate level of service includes 8 weekday and 3 weekend roundtrips. The low level of service includes 6 weekday and 3 Saturday roundtrips. Since the rail service along the M&L Branch would be a shuttle from Lawrence to Manchester, integration with MBTA's north side commuter rail fleet would not be necessary. The train sets, comprised of one locomotive and three coaches, would be dedicated to the New Hampshire service. Three sets of equipment would likely be required to operate either the Moderate or High Levels of Service with the Low Level of Service likely

requiring only two sets of equipment. The capital equipment costs range from $16.1M for the low level of service to $24.1M for the high level of service.

West Rail Corridor (Manchester-Lowell Line)

The New Hampshire Main Line (West Rail Corridor) runs in a north-south direction west of the I-93 highway corridor. From the site of the Manchester Station, the rail line crosses the Merrimack River to Bedford and follows the river through Merrimack and Nashua to Lowell, Massachusetts. From Lowell, the line continues south into Boston's North Station **(Figure 2.3-37)**.

Daily freight traffic operated by Springfield Terminal Railway presently uses the line. Service from Lowell to the Nashua Yard consists of main line and local freight trains, as well as "unit coal" trains that head north to a power plant in Bow, NH. Train service north of Nashua consists primarily of trains serving local industries and the unit coal trains serving Bow. Mainline through freight trains also operate between Nashua and Boston in the late evening or very early morning hours. In March 1999, GTI was operating the unit coal train to Bow three days a week. Local freight service was operated daily from the Nashua Yard south to service customers located along the line to Lowell. Similarly, local freight service was offered daily from Nashua to the north.

Restoration of commuter rail service along this line is being approached in a two-phase program. Phase 1, which is presently progressing through preliminary design, includes an extension of service from the existing MBTA commuter rail terminus in Lowell to a new park-and-ride station located adjacent to F.E. Everett Turnpike off of Spit Brook Road in Nashua. The Phase 1 effort would extend service approximately 11 miles for the Exit 1 Station. Phase 2, which has been considered as a mode alternative for the I-93 corridor, would further extend service from Nashua to Manchester, a distance of 19 miles. A downtown Nashua Station is expected to be incorporated along this line as part of Phase 2, and in doing so increase the use of the rail line. In addition, within this Phase 2 19-mile segment, three potential station sites were considered: Star Drive in Merrimack, the proposed Airport Access Road in Bedford, and Granite Street in Manchester.

The West Rail Corridor service would be typical commuter rail service operating with locomotive-hauled coaches between Manchester and North Station in Boston. This service would be an extension of the current MBTA Lowell Line service, providing service to all stations along the line. The travel time between Manchester and Boston would average 83 minutes.

Commuter rail service along the West Rail Corridor between Manchester and Lowell would require a capital improvements through rehabilitation of the existing track structure (rail, ties, ballast, sub-grade), bridges, the signal and communications system, grade crossings, stations and support facilities, as well as construction of some new infrastructure. The West Rail Corridor infrastructure cost estimate totals $73.2 M which includes $21.5 M for the section from Lowell to Nashua and $51.7 M

for the segment from Nashua to Manchester. These cost estimates do not include real estate or environmental mitigation.

Equipment needs for the West Rail Corridor service would vary depending on the amount of rail service provided. Three levels of service were considered. The high level of service would include 12 weekday and 4 weekend roundtrips. The moderate level of service would include 8 weekday and 3 weekend roundtrips. The low level of service would include 6 weekday and 3 Saturday roundtrips. The service would likely require between four and eight additional sets of equipment. The train sets, comprised of one locomotive and seven coaches, would be part of the MBTA north side commuter rail fleet. This equipment would not be dedicated solely to the NH rail service, but would be rotated among the various north side rail services. The capital equipment costs range from $53.3 M for the low level of service to $106.6 M for the high level of service. The high cost for equipment reflects the fact that the equipment will service a line extending from Manchester all the way to Boston. Such costs for other rail services assume that this equipment will be used along a shorter segment of rail line.

I-93 Basic and Enhanced Rail Corridors

The third and fourth rail alternatives considered as part of the I-93 Salem–Manchester improvements involve constructing a new light rail line within the existing I-93 highway corridor **(Figure 2.3-37)**. As such, both alternatives would result in a rail line within the I-93 highway corridor for 16.5 miles between Exit 5 in Londonderry and the Massachusetts state line. At the state line, for the I-93 Basic Rail Corridor, the rail alignment would leave the I-93 highway corridor and connect into the M&L Branch right-of-way continuing to Lawrence, MA. For the I-93 Enhanced Rail Corridor, the rail alignment would continue within the I-93 highway corridor through Massachusetts down to the Anderson Transportation Center. At the northern end for both rail corridors, near Exit 5, a connection would be made to the M&L Branch right-of-way along which a maintenance/layover facility would be sited. The Enhanced Option includes an extension of service to the Manchester Airport.

Due to the geometry of the I-93 corridor (i.e., the grades and curves) standard commuter rail would not be a viable option. However, Light Rail vehicles can operate on grades up to 4 percent and on curve radii as tight as 83 feet, and consequently can negotiate curves and grades encountered within the I-93 highway corridor. The most likely light rail system to be used in this corridor would be diesel light rail. This type of system, which is gaining favor in North America, does not require the construction of the electrified power system necessary to propel traditional light rail vehicles. The vehicles are propelled by diesel engines that are in each car. For the I-93 rail service these vehicles would operate in three-car consists.[17] A typical articulated light rail

[17] The term consist refers to the number of rail locomotives and coaches or vehicles that comprise a single train.

vehicle (double ended) in a three-car consist could seat 180 to 210 passengers with space for approximately 210 to 270 additional passengers standing. Assuming a shuttle type schedule of service similar to the east corridor, three sets of equipment would be required to operate a moderate or high level of service.

Due to safety considerations, the equipment planned for this corridor cannot be used on the commuter rail line between Lawrence and Boston. Therefore, passengers would be required to transfer to the MBTA Haverhill Line in Lawrence or to the MBTA line in Woburn for service to Boston. Total travel time between Exit 5 in Londonderry and Boston would average 83 minutes for the I-93 Basic Rail Corridor and a similar travel time (depending on the number of stops in Massachusetts) for the I-93 Enhanced Rail Corridor. In New Hampshire, stations would be located near the Manchester Airport, at Exit 5 in Londonderry, Exit 4 in Derry, Exit 3 in Windham, and Exit 2 in Salem. In New Hampshire, the alignment would be primarily located in the highway median, veering outside the median south of Exit 1 due to physical constraints.

The development of a light rail system along the I-93 corridor between Lawrence, MA and Londonderry would require substantial capital infrastructure improvements. The capital infrastructure program would include the construction of new track (rail, ties, ballast, sub-grade), bridges, grade crossings, and a signal and communications system along the entire corridor. The I-93 Basic Rail Corridor infrastructure cost estimate is $176.6 M ($7.7 million per mile). This cost estimate does not include real estate or environmental mitigation.

The additional cost to extend the I-93 rail corridor from Londonderry to Manchester, for comparison with the east rail corridors, would be $20 million for the option that relocates the rail line around the airport to $96.4 million for the option that constructs a tunnel under the runway at Manchester Airport.

The levels of service considered for this corridor were similar to those of the other rail corridor alternatives developed for the study. This included a high, moderate and low service level ranging from 12 to 6 daily weekday roundtrips between Exit 5 and Lawrence. These levels of service would require 6 vehicles for the low level of service and 9 vehicles for the moderate and high level of service. The capital equipment costs range from $24.5 M for the low level of service to $36.7 M for the high level of service.

2.3.5.3 Bus Service

For this project, two transit services were evaluated as mode options. They included: an expansion of existing commuter bus service to Boston; and an Enhanced Bus Service which was modified to a Ridesharing and Commuter Incentive Program to serve employment centers along the I-93 corridor in northern Massachusetts. Both services included the provision of a transit subsidy. NHDOT has further evaluated

and developed additional details in preparation for implementing Expanded Bus service and Enhanced Ride-sharing opportunities within the corridor. The following sections describe the 1) parameters and assumptions defining the two transit services; 2) transit fare subsidy and funding strategy; 3) operating and capital cost estimates; and 4) the proposed implementation schedule for these services.

Expanded Bus Service

The proposed Expanded Bus Service will expand on the current Concord Trailways commuter bus services, which provide service from Manchester and Londonderry (I-93, Exit 4) to Boston, MA. The proposed service is expected to operate on 30-minute headways from each park-and-ride facility in the peak direction during weekday peak periods, and on 60-minute headways during off-peak periods and on weekends. Service will be added initially from park-and-ride facilities at Exits 5 and 2. It is intended that service from the Exit 3 park-and-ride facility, which is programmed for construction later in the I-93 improvement project, will be added once the facility has been completed and as demand is warranted. Additionally, the NHDOT intends to maintain commuter service from the downtown Manchester bus station and from the existing Exit 4 park-and-ride facility. Each park-and-ride facility will include sufficient parking to accommodate demand, and basic passenger terminal facilities to be managed by the bus operator(s).

The Expanded Bus Service plan assumes that Exit 5 and Exit 2 services will operate independently during peak periods, with each bus only stopping at one park-and-ride facility. During off-peak periods and on weekends, the service may be combined to serve both the Exit 5 and Exit 2 facilities in one route.

The following is a proposed weekday service schedule developed for the purposes of this study. Modifications and opportunities for cost saving improvements may be made to the service schedule as the NHDOT works with the contracted bus service provider. Service frequency, departure times, stops and stopping patterns may also be changed based on the needs of the service.

Table 2.3–2
Proposed I-93 Commuter Bus Schedule: Weekday Service

Exit 5				Exit 2			
Southbound		Northbound		Southbound		Northbound	
Depart Exit 5	Arrive Boston	Depart Boston	Arrive Exit 5	Depart Exit 2	Arrive Boston	Depart Boston	Arrive Exit 2
5:00 AM	5:55 AM	6:30 AM	7:25 AM	5:00 AM	5:40 AM	6:30 AM	7:10 AM
5:30 AM	6:25 AM	7:30 AM	8:25 AM	5:30 AM	6:10 AM	7:30 AM	8:10 AM
6:00 AM	7:05 AM	8:00 AM	8:55 AM	6:00 AM	6:50 AM	8:00 AM	8:40 AM
6:30 AM	7:35 AM	8:30 AM	9:25 AM	6:30 AM	7:20 AM	8:30 AM	9:10 AM
7:00 AM	8:15 AM	9:30 AM	10:25 AM	7:00 AM	8:00 AM	9:30 AM	10:10 AM
7:30 AM	8:50 AM	10:30 AM	11:25 AM	7:30 AM	8:35 AM	10:30 AM	11:10 AM
8:00 AM	9:15 AM	11:30 AM	12:25 PM	8:00 AM	9:00 AM	11:30 AM	12:10 PM
9:00 AM	10:15 AM	12:30 PM	1:25 PM	9:00 AM	10:00 AM	12:30 PM	1:10 PM
10:00 AM	11:00 AM	1:30 PM	2:25 PM	10:00 AM	10:50 AM	1:30 PM	2:10 PM
11:00 AM	12:00 PM	2:30 PM	3:25 PM	11:00 AM	11:50 AM	2:30 PM	3:10 PM
12:00 PM	1:00 PM	3:30 PM	4:35 PM	12:00 PM	12:50 PM	3:30 PM	4:20 PM
1:00 PM	2:00 PM	4:00 PM	5:05 PM	1:00 PM	1:50 PM	4:00 PM	4:50 PM
2:00 PM	3:00 PM	4:30 PM	5:35 PM	2:00 PM	2:50 PM	4:30 PM	5:20 PM
3:00 PM	4:00 PM	5:00 PM	6:05 PM	3:00 PM	3:50 PM	5:00 PM	5:50 PM
4:00 PM	5:00 PM	5:30 PM	6:35 PM	4:00 PM	4:50 PM	5:30 PM	6:20 PM
4:30 PM	5:30 PM	6:00 PM	7:05 PM	4:30 PM	5:20 PM	6:00 PM	6:50 PM
5:00 PM	6:00 PM	6:30 PM	7:35 PM	5:00 PM	5:50 PM	6:30 PM	7:20 PM
6:00 PM	7:00 PM	7:30 PM	8:25 PM	6:00 PM	6:50 PM	7:30 PM	8:10 PM
7:00 PM	8:00 PM	8:30 PM	9:25 PM	7:00 PM	7:50 PM	8:30 PM	9:10 PM
8:00 PM	9:00 PM	9:30 PM	10:25 PM	8:00 PM	8:50 PM	9:30 PM	10:10 PM
9:00 PM	10:00 PM	10:30 PM	11:25 PM	9:00 PM	9:50 PM	10:30 PM	11:10 PM
10:00 PM	10:55 PM	11:30 PM	12:25 AM	10:00 PM	10:40 PM	11:30 PM	12:10 AM
11:00 PM	11:55 PM	12:30 AM	1:25 AM	11:00 PM	11:40 PM	12:30 AM	1:10 AM

Enhanced Bus/Ride-sharing and Commuter Incentive Program

The Enhanced Bus service defined in previous studies would provide access between New Hampshire and employment centers along the I-93 corridor in northern Massachusetts. The enhanced bus service would include two routes. The first route would originate at Exit 5 with a stop at Exit 4 while the second route would originate at Exit 4 with a stop at Exit 3. As with the Expanded Bus service, sufficient parking was assumed to be available at each bus station. It was assumed that both routes would stop at Exit 45 (River Road), Exit 42 (Dascomb Road), Exit 38 (Route 129) and Exit 37 (The Anderson Transportation Center) in Massachusetts.

A stop at Exit 2 was not included with this option because of the increase in travel time that would result. The riders who would use an Exit 2 stop could use the Exit 3 stop. The number of passengers that would be lost (from Exits 5, 4, and 3) by adding an additional stop is expected to be about the same magnitude as the number that would be added by including a stop at Exit 2. In addition, an Exit 2 bus stop for riders to employment centers along I-93 in northern Massachusetts would have less appeal given the relatively short distance between Exit 2 and the employment centers. Commuters would be more likely to drive directly to the employment centers in such a situation rather than drive to a bus stop, park, and take a bus.

While developing the implementation plan for the Enhanced Bus service, NHDOT investigated the feasibility of this type of program for the I-93 corridor. Working collaboratively with the local MPOs, TMOs and TMAs, it was learned that previous attempts to provide local bus service along the I-93 corridor have not been successful or cost-efficient. Existing programs along the I-93 corridor, despite a low-cost or free fare and heavy marketing to commuters, have not come close to projected ridership. Several area bus services of this type have been reduced, modified or not even initiated due to the inability to attract riders for this type of regularly scheduled bus service along the I-93 corridor to employment centers with ample free parking.

Based on these discussions, it was determined that the demand for this type of service is not sufficient to begin service at this time. It would be more beneficial to provide an Enhanced Ride-sharing program, such as vanpooling or carpooling, in conjunction with a commuter incentive program along the corridor. This type of service would be provided until such time that a sufficient ridership base is developed for scheduled bus service. NHDOT will continue to work with Massachusetts' statewide commuter service organization, CARAVAN for Commuters, Inc., to develop concepts for a ride-sharing program from southern New Hampshire that serves the entire I-93 corridor. The Commonwealth of Massachusetts contracts with a private, non-profit organization that provides assistance to commuters, companies, and TMAs in efforts to improve air quality, reduce traffic congestion, and maximize mobility. NHDOT proposes to subsidize a commuter incentive program in its early stages.

A commuter incentive program provides financial rewards for commuters who choose transit, carpool or vanpool, or other alternatives to driving alone. It is a cost-effective approach to provide alternatives in a market with limited transit demand.

It is NHDOT's intention to continue to work with the Commonwealth of Massachusetts and their contractor service organization to develop a plan for a ridesharing and commuter incentive program.

Transit Fare Subsidy

Under some situations, a transit fare subsidy was also considered in the analysis of ridership potential for the transit service options. The subsidized fare of $3.00 to $3.40 per one-way trip is comparable to the current MBTA commuter rail fare. The reduced fare was designed to make the cost of commuter bus service competitive with commuter rail service and was set at the same level at which commuter rail service is subsidized by the MBTA in Massachusetts. In this way, the transit services could be evaluated in terms that are comparable to rail service.

Transit Funding Strategy

NHDOT is developing a strategy to fund the proposed transit services during I-93 construction. All appropriate avenues of funding for this service are being pursued including CMAQ, FTA, etc. It is anticipated that CMAQ funds will be used to purchase vehicles for the Expanded Bus Service, to cover the anticipated operating deficit for the Expanded Bus Service for the first three years of operation. FTA capital fund allocations for bus purchase are anticipated to be used in conjunction with CMAQ funds to finance bus purchases. The long-term viability of these services will be dependent upon the ability to make these services self-sufficient after the initial three-year period. NHDOT has been working with the private bus operators to determine strategies, such as marketing programs, which will assist in making the service self-sufficient in the future. NHDOT anticipates that approximately $300,000 will be allocated for a marketing program during the first three years of service, a portion of which may be funded by CMAQ funds. In an effort to make the service financially sustainable, NHDOT is also considering the possibility of registering the new vehicles as state vehicles, which would allow the provider to reduce costs on fuel, registration and tolls.

Additionally, NHDOT has proposed to use $300,000 in CMAQ funds to subsidize the commuter incentive programs that would encourage use of both the Expanded Bus service and the Ride-sharing Program. NHDOT is currently working with the Commonwealth of Massachusetts and its contractor to create a Commuter Incentive Program and to identify any associated costs to the State.

Cost Estimates

Two types of costs have been identified for the transit services outlined: annual operating and capital costs. Order of magnitude cost estimates have been developed for each component and are summarized in the following sections.

Annual Operating Costs

These costs were derived based on an estimate of the number of vehicle revenue hours that would be operated in a year, and on an average operating cost per vehicle revenue hour. The number of annual vehicle revenue hours was estimated by multiplying the number of trips per day by the length of each trip, and then

multiplying the resulting figure by the number of service days per year (251 weekdays and 114 weekend days). Additional operating costs may be created if buses must travel significant "deadhead" miles.

The estimated annual operating cost for the Expanded Bus Service was determined by multiplying the number of annual vehicle revenue hours by $96.60, the average operating cost for one bus in revenue service for one hour across U.S. transit agencies in 2001. (Source: 2001 National Transit Summaries and Trends).

The estimated annual operating costs for the Expanded Bus Service alternative are summarized in Table 2.3-3. [It is anticipated that there will be little to no new costs for the Commuter Incentive Program established as part of this project beyond proposed CMAQ funding. However, NHDOT is currently working with the Commonwealth of Massachusetts to finalize the program and to identify associated annual operating costs.]

Table 2.3-3
Estimated Annual Operating Cost for Expanded Bus Service

	Expanded Service Weekday	Expanded Service Weekend
Round Trips Per Day	46	19
Vehicle Revenue Hours Per Day	115	47.5
Days per year	251	114
Annual Vehicle Revenue Hours	28,865	5,415
Operating Cost per Vehicle Revenue Hour	$96.60	$96.60
Annual Operating Cost	$2,800,000	$525,000

The Total Annual Operating Cost for the Expanded Bus Service is estimated to be $3,325,000. The Expanded Bus Service operating plan assumes that the buses layover in Boston during the midday. There may be additional costs associated with the service for storing these buses in Boston for the day depending on the operator; however, midday layover costs are not included in this estimate. Operating costs may need to be adjusted if buses must lay over in outlying locations.

Annual Capital Costs

The estimated capital cost for the Expanded Bus Service includes the capital cost for vehicles required to provide the service. Also included for the Expanded Bus Service is the capital cost of constructing a bus maintenance/layover facility in the Exit 5 area. Construction of a bus maintenance/layover facility minimizes annual operating costs. The Expanded Bus Service may also require additional capital costs for the layover of buses in Boston. The costs of any required layover facility use

would be included in the operator's costs as either capital costs (i.e., cost of facility) or operating cost (i.e., cost to deadhead to a layover site).

Total Annual Costs

The estimated total annual costs for the Expanded Bus Service combine the annual operating costs and the annual capital costs. A summary of costs is provided in Table 2.3-4. The estimated capital costs do not include construction of park-and-ride facilities, which are included elsewhere, or estimates for docking space at South Station in Boston that may be necessary for the Expanded Bus Service.

Table 2.3-4
Total Annual Costs — Expanded Bus Service

	Expanded Bus Service
Estimated Annual Operating Cost	$3,300,000
Estimated Annual Capital Cost	$1,050,000
Total Annual Cost	$4,350,000

Bus Procurement Costs

The operating plan developed for the Expanded Bus Service is based on the operation of highway coaches with seating capacity for 51 passengers. The capital cost for these buses has been estimated at $450,000 per bus including in-plant inspection. The Expanded Bus Service requires the procurement of 14 buses . The capital cost would be approximately $6,300,000.

Bus Layover and Maintenance Facility (Exit 5)

In addition to the park-and-ride terminal facilities, NHDOT plans to construct a bus layover and maintenance facility for the buses required to service the I-93 corridor. The facility will be located adjacent to the Exit 5 park-and-ride lot (**Figure 2.3-41**; Section 2.3.5.4). The site currently under consideration is located at the northwest quadrant of the Exit 5 Interchange immediately north of the abandoned Manchester-Lawrence railroad corridor. This location would also allow for the construction of additional parking should the Exit 5 park-and-ride require expansion in the future. Based on discussions with the current bus service operator, providing a facility at Exit 5 will reduce the costly deadheading of buses from Concord or another location (currently the Concord Trailways bus layover and storage is located in Concord).

The facility would include a maintenance building approximately 10,000 square feet in size for maintenance, washing, and fueling buses and a second, smaller building for overnight storage of buses. The maintenance building includes office space and parts storage, and two or three maintenance bays including a pit for maintaining the vehicles. Indoor storage in a building kept above freezing temperatures provides buses that are warm and thus ready to accept passengers, and also free of ice and snow that otherwise presents a hazard to other motorists. The bus layover and maintenance facility would be constructed as part of the overall infrastructure improvements along the corridor, as with the construction of the park-and-ride lot and bus terminals.

Implementation Schedule

NHDOT is committed to implementing the Expanded Bus service and Enhanced Ride-sharing and Commuter Incentive program as funding permits. It is NHDOT's intention to begin the process of procuring the new fleet in early 2004. By mid-2004, NHDOT plans to advertise a Request for Proposals to solicit operators for the Expanded Bus service. Implementation of the Expanded Bus service in the corridor will occur in late 2005 to correspond with the opening of the Exit 5 and Exit 2 park-and-ride facilities, and in advance and anticipation of the I-93 mainline construction.

NHDOT is currently working with the Commonwealth of Massachusetts to determine a schedule for initiating the Commuter Incentive program within the same timeframe.

2.3.5.4 I-93 Park-and-Ride Facilities

Park-and-ride facilities provide necessary support for HOV and transit services and ultimately help support TDM measures. Without adequate parking available, these services cannot be utilized to the fullest extent. Estimates for park-and-ride usage at each of the four existing and proposed park-and-ride lots were developed by analyzing origin and destination patterns for commuters from the towns in the vicinity of each park-and-ride lot traveling to Boston and other employment centers in Massachusetts.

To support transit and HOV options, new park-and-ride facilities were proposed along I-93 at Exits 2, 3, and 5. The proposed facility at Exit 3 would replace the existing facility west of Exit 3, which is underutilized because of its distance from the interchange and access problems. The existing park-and-ride facility at Exit 4 would continue to provide bus service. Given the construction of additional park-and-ride sites, demand at the Exit 4 site would, in the near term, likely decrease somewhat.

The following sections describe the location and size of each of the park-and-ride facilities, as envisioned. Each new park-and-ride site was located to support an expansion of bus service as well as commuter rail corridor service, if instituted

within the I-93 highway corridor. Each park-and-ride facility was sized to accommodate projected rail, bus and HOV ridership.

The NHDOT is coordinating with bus service providers to consider opportunities to provide bus service at the proposed park-and-ride facilities.

Exit 2 Park-and-Ride

The proposed park-and-ride lot concept developed for Exit 2 is located in the southeast quadrant of the Exit 2 Interchange and is shown in **Figure 2.3-38**. The facility would be located between Fairmont Road and Raymond Avenue and extend along Boyer Lane, adjacent to the northbound off-ramp. Access for the facility would be provided via a signalized intersection at Raymond Avenue and South Policy Street, which is approximately 2,000 feet south of the Pelham Road/South Policy Street intersection. Approximately 800 feet of Raymond Avenue and 1,100 feet of South Policy Street would be reconstructed. The projected demand from potential carpooling and bus ridership for bus service to Boston from this location is estimated to be 300 spaces.

This layout would involve several parcels of land, including the acquisition of seven homes and one business. This preliminary concept would allow for the construction of approximately 430 spaces with potential for expansion to the south to accommodate a future rail station. The estimated construction cost (excluding right-of-way costs) for the park-and-ride lot, including buildings/shelters, and the access modifications to Raymond Avenue and South Policy Street is $2.3 million. A pedestrian bridge would be required to access the future rail station platform in the median. The NHDOT is coordinating with bus service providers to consider opportunities to provide bus services at this location.

Exit 3 Park-and-Ride

The existing park-and-ride lot in Windham is located on NH 111 approximately 0.8 miles west of I-93 with access provided via Wall Street. The lot was upgraded in 1998 to further encourage travelers to use the facility. This existing facility provides parking for approximately 150 vehicles and was previously served by bus transit to Boston; however, this service was ended due to the lack of riders and the delay buses experienced in getting to and from I-93. The projected demand from potential carpooling and bus ridership for bus service to Boston from this location is estimated to be 200 spaces.

Two new park-and-ride options (that complement the I-93 Northbound Shift option or the Tight Shift option) have been developed, one of which would serve as a replacement to the existing Exit 3 facility. Both options are conveniently located closer to I-93 at the Exit 3-Interchange area. Both of these options would allow for the construction of approximately 525 parking spaces with the potential for future expansion to accommodate a rail station. The NHDOT is coordinating with bus service providers to consider opportunities to provide bus services at this location.

For the I-93 Northbound Shift option (Section 2.3.3), the new park-and-ride facility is located in the median area between the two barrels of I-93. The median in the Exit 3 area is currently 1,000 feet wide and can accommodate this type of facility. Access would be provided via a new connector road intersecting with an improved NH 111 at a signalized intersection located between the NH 111/I-93 northbound and southbound ramp intersections. The facility would be situated parallel to the southbound barrel of I-93, with approximately 100-200 feet separating the facility from the highway. Access to a future rail line at Exit 3 would be via a direct connection. This layout would involve approximately 4 parcels of land. The estimated construction cost (excluding right-of-way costs) of the Northbound Shift option park-and-ride lot, including buildings/shelters, and the construction of a new access road from NH 111 to the park-and-ride lot is $3.8 million.

For the Tight Shift option (Section 2.3.3), the new park-and-ride facility would be located outside the median area east of the proposed relocation of the northbound barrel. Access would be located from a 0.5 mile relocated section of NH 111A connecting to NH 111 at a signalized intersection. The new section of NH 111A would be widened to provide a left-turn lane for vehicles entering the proposed park-and-ride. The Town of Windham requested that the bus terminal and associated building be located adjacent to the relocated section of NH 111A with the parking lot behind to be more compatible with the envisioned gateway/village zoning district. The Town also suggested that the parking lot be constructed in stages to meet the actual demand. This layout would involve two parcels of land. The estimated construction cost (excluding right-of-way costs) of the Tight Shift option park-and-ride lot, including buildings/shelters, the widening of NH 111A and the construction of access roads is $ 4.7 million. Access to a future rail line at Exit 3 would be via a pedestrian bridge over the northbound barrel, which would access a rail station platform in the median.

The proposed Exit 3 Park-and-Ride options are shown in **Figure 2.3-39**.

Exit 4 Park-and-Ride

Exit 4 has an existing park-and-ride facility located in the northwest quadrant of the Exit 4 Interchange. Access is provided via Hampton Drive, approximately 1100 feet west of the NH 102/southbound off-ramp intersection. This existing facility provides parking for approximately 470 vehicles and is currently served by Concord Trailways. The projected demand from potential carpooling and bus ridership for bus service to Boston from this location is estimated to be 450 spaces.

The existing park-and-ride facility would be retained and minor modifications would be made to the current parking layout to accommodate a new terminal building with either the easterly or the westerly I-93 widening alternatives (Section 2.3.3). However, the westerly widening option, which requires the relocation of the southbound off-ramp to the west, would impact the existing park-and-ride facility. The impact would require the relocation of 900 feet of the existing park-and-ride

access road resulting in the elimination of approximately 20 parking spaces. The easterly I-93 widening option would have no impacts on the existing park-and-ride facility.

The existing park-and-ride facility will provide continued service to current and future ridership, however this facility would not allow for convenient access to a future rail line in the median. Conceptual evaluations to expand the park-and-ride lot in the Exit 4 area that would provide connectivity for future rail showed potentially substantial impacts to environmentally sensitive property (Woodmont apple orchard). Whether a new facility would eventually replace the existing facility will need to be determined as part of a future rail study to consider, in more detail, potential rail service needs. The estimated construction cost (no right-of-way costs anticipated) of the building/shelter and modifications to the existing park-and-ride lot is $0.6 million. The proposed park-and-ride modifications for the easterly and westerly widening options are shown in **Figure 2.3-40**.

Exit 5 Park-and-Ride

Five proposed park-and-ride concepts were developed for the Exit 5 area. The projected demand from potential carpooling and bus ridership for bus service to Boston from the Exit 5 area is estimated to be 500 spaces.

The first park-and-ride concept, Option 1, is located in the northwest quadrant of the interchange adjacent to the I-93 Exit 5 southbound off ramp and is shown in **Figure 2.3-41**. The Option 1 park-and-ride is located on property used by Waste Management, Inc., as a waste transfer facility. The land needed to develop this facility would include approximately 16 acres from this private business. Primary access would be provided from Symmes Drive, which connects to NH 28. Approximately 450 feet of Symmes Drive would be reconstructed and connected to a new signalized intersection with an improved NH 28. Secondary access would be provided by a right turn in (opposite Perkins Road) approximately 1000 feet east of the Symmes Drive/NH 28 intersection. This access would also provide an opportunity for NH 28 westbound traffic to reverse direction. Those vehicles trying to reverse direction could do so by turning right into the park-and-ride lot, then turning left onto Symmes Drive and then turning left onto NH 28 eastbound at the NH 28/Symmes Drive signalized intersection. The proposed facility would accommodate approximately 600 parking spaces. The estimated construction cost (excluding right-of-way costs) of the park-and-ride lot, including buildings/shelters, and the reconstruction of approximately 450 feet of Symmes Drive for access to the park-and-ride lot is $2.1 million. Future access to the rail line (assuming it is located on the old abandoned rail corridor) would be direct.

The second concept, Option 2, would also be located in the northwest quadrant of the interchange closer to Symmes Drive and on properties west of the transfer station. This option is shown in **Figure 2.7-18 and Figure 2.3-41** as part of the Selected Alternative. The Option 2 layout, as embodied in the Selected Alternative, was

modified following the DEIS to lessen the property impacts, predominantly utilizing the Cycle World site (3 businesses) and two other vacant parcels with partial property impacts to the Exxon gas station, Waste Management Transfer Center, and a Senior Care Center. Primary access would be provided from Symmes Drive, which connects to NH 28. Approximately 500 feet of Symmes Drive would be reconstructed and connected to a new signalized intersection opposite Vista Ridge Drive. Secondary access to the park-and-ride would be provided by a right-turn in drive approximately 400 feet east of the Symmes Drive/NH 28 intersection. Because the proposed reconstruction and widening along NH 28 precludes the vehicles from the adjacent transfer station property from making left turns at its existing drive, a new drive from the transfer station would connect to the proposed park-and-ride access road, allowing the transfer station gain access to the proposed Symmes Drive signal at NH 28. The proposed facility would accommodate approximately 480 parking spaces. Future access to the rail line would be similar to Option 1 and would be direct. The estimated construction cost of Option 2 is $2.0 million.

A third park-and-ride concept, Option 3 would be located in the southwest quadrant of the I-93 Exit 5 Interchange approximately 0.25 mile south of NH 28 and parallel to the southbound barrel of I-93. This concept is shown in **Figure 2.3-41**. The land needed to develop this facility would include approximately twenty acres from four residential properties. Access to the park-and-ride would be provided via a 1000-foot connector road from Perkins Road, south of the hotel. In order to allow the users full access to the proposed park-and-ride, approximately 0.4 mile of Perkins Road would be relocated and reconstructed from the new park-and-ride connector road westerly to NH 28 opposite the Symmes Drive intersection. The NH 28/Symmes Drive intersection would be signalized. The proposed facility would accommodate approximately 700 parking spaces. A pedestrian bridge over I-93 southbound would be required to access the future rail station platform in the median, similar to what would be required at Exit 2 and possibly Exit 3. The estimated construction cost (excluding right-of-way costs) of the park-and-ride lot, including buildings/shelters, and the reconstruction of approximately 0.4 mile of Perkins Road and a 1,000 foot access road to the park-and-ride lot is $5.2 million.

Option 4, is located in the southeast quadrant of the Exit 5 Interchange between NH 28 and I-93, opposite Liberty Drive and on property currently occupied by a Sunoco Station. This option is shown in **Figure 2.3-41**. The proposed facility would accommodate approximately 525 parking spaces. Primary access would be provided directly to NH 28 at a proposed signalized intersection opposite Liberty Drive. The proposed improvements to NH 28 to accommodate this park-and-ride lot are generally similar to improvements under consideration to accommodate access to Liberty Drive and the Sunoco gas station as described in Section 2.3.3.3 **NH 28 On-line and NH 28 Relocation Options**. However, because of a greater volume of northbound NH 28 left-turn vehicles entering the park-and-ride (compared to the Sunoco Station left-turn volume), the left-turn lane and the widening of the NH 28 southerly approach to the proposed Liberty Drive/NH 28 signalized intersection would be extended southerly an additional 200 feet. Access to a future rail platform in the

median would require the use of a pedestrian bridge that would span the northbound off-ramp and the northbound barrel. The estimated construction cost (excluding right-of-way costs) of the park-and-ride lot, including buildings/shelters, and the additional 200 feet reconstruction of NH 28 is $1.8 million.

Option 5 would impact three parcels of land located along the north side of Auburn Road approximately 0.25 mile from the NH 28. This concept is shown in **Figure 2.3-41**. Access to the park-and-ride lot would be directly from Auburn Road. The properties impacted include one undeveloped parcel designated as a Tree Farm and two residential properties. The proposed facility would accommodate approximately 500 parking spaces. Approximately 1000 feet of Auburn Road would be widened and reconstructed beginning at the proposed improvements to the intersection of Independence Drive/Auburn Road (as part of the proposed reconstruction of NH 28) and extending northerly. The widening would extend the proposed left- turn lane at Independence Drive/Auburn Road northerly to the proposed park-and-ride entrance. The proposed improvements to NH 28 to accommodate this park-and-ride lot are generally similar to improvements under consideration to accommodate access to Liberty Drive and the Sunoco gas station and as described in Section 2.3.3.3 **NH 28 On-line and NH 28 Relocation Options**. However, with the resultant increase in volume of traffic using the proposed Auburn Road park-and-ride, the left-turning traffic (570 vph in the design year 2020 PM) turning into Liberty Drive would extend the length of the left-turn vehicle queue to approximately 475 feet. This queue length can be accommodated within the proposed NH 28 widening and the overall NH 28/Liberty Drive intersection design year level of service is LOS D. The operational LOS for the left-turn movement into Liberty Drive would be at capacity (LOS E).

Future rail access to the park-and-ride lot could be provided to the abandoned Manchester and Lawrence rail line (if reactivated), but not the I-93 Rail Corridor. Currently, portions of the former rail corridor right of way for this section is owned privately and being developed into an office park development. The estimated construction cost (excluding right-of-way costs) of the park-and-ride lot, including a terminal building, and the reconstruction of approximately 900 feet of Auburn Road is $2.1 million.

2.3.5.5 Ridership Projections

This section summarizes the analysis of ridership projections for mode alternatives originally presented in Volume 1 of the *Rationale Report* (*January 2001)*. The development of ridership projections for rail, bus, and high occupancy vehicle (HOV) lane options were developed in two phases. In the first phase, preliminary analyses were conducted to evaluate individual rail, bus and HOV mode options. Based on the results of the preliminary analyses of individual mode options, 14 mode combinations were identified for further analysis.

Analysis of Individual Rail, Bus, and HOV Mode Options

The individual mode options that were analyzed include the four rail and two HOV lane options described above plus six bus options. The six bus options are all based on the Expanded Bus Service described above in combination with a fare subsidy option and the HOV lane options. The six bus options include service with and without a fare subsidy combined with no HOV facility, an HOV facility in New Hampshire only, and an HOV facility in New Hampshire and Massachusetts.

Methodology for Projecting Ridership for Rail, Bus, and HOV Mode Options

The method used for projecting rail and bus ridership is described in the *National Cooperative Highway Research Program (NCHRP) Report 187: Quick-Response Urban Travel Estimation Techniques and Transferable Parameters*. This or similar methods have been used for planning transit projects by public agencies nationwide. The main inputs used for the ridership forecasts were the 1990 Journey-to-Work (JTW) data, population and employment forecasts, existing and future travel times, transit travel time, and auto and transit costs. Projections were developed for each mode option assuming no other options were provided.

The process for projecting 2020 ridership for each rail and bus option entails projecting the 2020 commuter population for each market/service area associated with a proposed rail or bus station. To determine how much of the 2020 commuter population would take transit, the auto and rail impedances for each origin (home location) and destination (work location) pair, were compared. Transit and automobile travel impedances were measured in minutes and included total travel time associated with each trip plus out-of-pocket costs converted to time (minutes). The transit share was then calculated for each town by using the logit mode choice equation described in the NCHRP Report 187.

A similar process was followed for projecting HOV lane usage. The physical configuration of the HOV facility did not factor into the calculations of ridership. The analysis methodology assumed that there would be sufficient enforcement of restrictions on lane use that would keep the HOV lane free flowing until HOV volume reached the capacity of the HOV lane. All non-HOVs were restricted to using the available general purpose lanes and the travel time in the general purpose lanes was estimated based on projected levels of service. The analysis was conducted for southbound travel in the morning peak period and northbound travel in the evening peak period.

Since the mode choice equation from the NRPC Report had been calibrated for another geographical area, specific calibration for the I-93 corridor was undertaken. This was done by using the equation to estimate ridership for the existing bus service. The calculated ridership was then compared to actual boardings at the downtown Manchester Station and the park-and-ride counts at the Londonderry (Exit 4) stop. In order to match the actual boardings, adjustments were made to the various model parameters.

Preliminary Ridership Projections for Mode Options

The West Rail Corridor generated the smallest ridership of the four rail options with approximately 430 daily boardings. The East and I-93 Basic Rail Corridors generated more than twice as many daily boardings as the West Rail Corridor with approximately 960 and 900 daily boardings, respectively. These two corridors generated essentially the same ridership because they are parallel and close to each other, serve the same market areas, and provide similar service. As a result of the similarity in ridership between the two, it was decided to use only the East Rail Corridor in any subsequent analyses. The Enhanced Rail Corridor generated the largest Boston bound ridership with about 1,160 daily boardings. In addition, it included about 650 boardings for commuters destined to I-93 employment centers in Massachusetts.

The largest projected bus ridership was for the option that included a fare subsidy and an HOV lane in both New Hampshire and Massachusetts. It generated 2,200 boards daily. The provision of an HOV lane in New Hampshire-only resulted in virtually the same bus ridership as that with no HOV lane, and consequently was dropped from further consideration. The provision of a fare subsidy increased ridership by 14 to 19 percent.

The analysis of HOV options indicated there would not be sufficient travel time savings to induce the formation of new carpools or vanpools with an HOV lane in NH only. This reflects the conclusions of the bus analysis that an HOV lane in New Hampshire only would not increase bus ridership. Therefore, all further analyses of HOV lanes included lanes in both New Hampshire and Massachusetts.

Analysis of Rail, Bus, HOV, and Highway Widening Mode Combinations

Based on the preliminary analysis results, those individual mode options deemed feasible and practicable were combined with each other and various highway lane configurations (i.e., two, three, or four general use lanes in each direction). Fourteen mode combinations were identified to test the potential interaction between rail, bus, HOV and highway options, and to determine how the ridership generated by these different combinations of mode options might influence the need for highway improvements. In developing the mode combinations, an additional bus option, Enhanced Bus service, was added. As described earlier, it would provide access between New Hampshire and employment centers along the I-93 corridor in Northern Massachusetts similar to the service provided by the Enhanced Rail option.

The purpose of the analysis of mode combinations was to determine what combinations would attract the greatest ridership and divert the largest number of drivers from I-93. These diversions were then analyzed to determine their effect on the need for highway improvements. Specifically, the highway level of service with these mode combinations was calculated to determine if a desired level of service on

the highway could be achieved with a more limited set of highway improvements (see Table 2.3-6).

Description of Combinations Analyzed

Table 2.3-5 defines how the mode options were combined. The table includes an identification number for each combination, the number of general purpose lanes provided on I-93, and a check mark to indicate which of the individual bus, rail, and HOV options are included.

The following provides an explanation of each of the mode combinations tested:

- Combinations 1-3 test the three rail options carried forward with two general purpose highway lanes (no highway expansion). Rail ridership is expected to be higher with two lanes because of increased highway congestion and increased highway travel time.

- Combinations 4-5 also include only two highway lanes and test Expanded and Enhanced bus services with an HOV lane. Mode combination 5 also includes a bus subsidy and the West Rail.

Table 2.3-5
Rail, Bus, HOV Lane Mode Combinations

Mode Combination ID Number	Number of General Purpose Lanes[1]	HOV Lane[2]	Expanded Bus	Enhanced Bus	Bus Subsidy	Enhanced I-93 Rail	West Rail	East Rail
1	2						✓	
2	2							✓
3	2					✓		
4	2	✓	✓	✓				
5	2	✓	✓	✓	✓		✓	
6	3		✓	✓				
7	3	✓	✓	✓				
8	3		✓	✓	✓		✓	
9	3	✓	✓	✓	✓		✓	
10	4		✓	✓				
11	2	✓		✓	✓			✓
12	3	✓		✓	✓			✓
13	2					✓		✓
14	3	✓	✓	✓	✓	✓		

1 Number of general purpose lanes in each direction north of Exit 1. Two lanes in each direction represents the highway no-build condition except for the segment of I-93 south of Exit 1 which currently has three general purpose lanes in each direction.
2 The HOV lane is a third lane in addition to the existing two general purpose lanes for Alternatives 4, 5 and 11, and a fourth lane for Alternatives 7, 9, 12 and 14. It extends from south of I-293 to I-95 (Route 128) in Massachusetts.

- Combination 6 includes 3 general use lanes and tests Expanded and Enhanced bus service without a subsidy.
- Combination 7 adds an HOV lane to Combination 6.
- Combination 8 includes 3 general use lanes and tests Expanded and Enhanced bus service with a subsidy and west rail service.
- Combination 9 adds an HOV lane to Combination 8.
- Combination 10 includes 4 general use lanes and tests Expanded and Enhanced bus service.
- Combinations 11 and 12 combine Enhanced Bus (service to northern Massachusetts), a bus subsidy, an HOV lane, and East Rail (service to Boston) with two and three general purpose lanes, respectively.
- Combination 13 tests Enhanced Rail with East Rail and two general purpose highway lanes.
- Combination 14 combines both bus services, an HOV lane, a bus subsidy, and Enhanced Rail with three general purpose highway lanes.

Methodology for Projecting Ridership for Mode Combinations

The general methodology for projecting ridership with individual modes was used for mode combinations. However, when the mode options were combined, the interaction between transit services serving similar markets was considered to avoid double counting and over estimating total transit ridership. In this stage of analysis, each service/market area was assigned to a specific station for a particular transit option based on the total impedance for each option that could serve a particular area. In general, a service or market area was assigned to the transit route with the least impedance.

For the analysis of mode combinations, a bus subsidy was included in each combination that included both a rail line and a bus option. This was done to make the bus options competitive with the rail options when they were combined together. In mode combinations without a rail option, no bus subsidy was included.

For the analysis of combinations with an HOV option, it was assumed that the HOV lane would continue to I-95 (Route 128) in Massachusetts. It was also assumed that the HOV lane was in addition to whatever number of general purpose lanes were included in the analysis. However, the total number of lanes, including the HOV lane, was never more than four in each direction.

Ridership Projections for Mode Combinations

In reviewing the results from analysis of ridership for the various modes in different combinations with each other, Mode Combinations 3 and 13 have the largest projected daily transit ridership with 3,365 southbound trips. Both combinations include Enhanced Rail with two general purpose lanes on I-93. Although Combination 13 also includes East Rail, the ridership projection is the same as for Combination 3 because the East Rail serves the same market as Enhanced Rail.

The next largest ridership projections are for Mode Combinations 5 and 14 with just under 3,000 daily southbound trips each. Both of these combinations include Enhanced and Expanded bus service, an HOV lane, and a bus subsidy. The most effective transit combinations involve Enhanced Rail or Enhanced and Expanded Bus service with an HOV lane and bus subsidy.

To determine the impact of the transit mode combinations on roadway conditions, the projected daily transit ridership was diverted from projected traffic volumes on I-93. The reduction in daily person trips was converted to a reduction in vehicle trips by dividing by the average auto occupancy rate for the area (1.11) from the 1990 journey-to-work (JTW) census data.

Diversions from single occupant vehicles to HOVs resulting from the provision of an HOV lane were also calculated. The number of HOVs created was subtracted from the number of SOVs eliminated to calculate the net reduction in vehicles. The largest reduction in vehicles resulting from the HOV lane is 480 daily southbound vehicles, and occurs when there are only two general purpose lanes on I-93. With three general purpose lanes, the number of vehicles diverted is reduced to about 290.

The largest total projected reduction in daily vehicles between Exit 1 and the Massachusetts state line is for Mode Combination 5 with a reduction of almost 2,400 daily southbound vehicles. This represents 3.3 percent of the total daily directional volume of 71,100. Mode Combinations 3 and 13 result in a reduction of almost 2,300 vehicles.

Existing congestion on I-93 extends over a three hour period in both the morning and evening. Vehicle reductions for these three-hour peak periods were estimated separately for transit and HOV modes from the daily reductions. Daily transit reductions were converted to three-hour peak period reductions assuming that 82 percent of daily one-way transit volume occurs in the peak period. The 82 percent was estimated from existing MBTA commuter rail ridership data. The daily HOV vehicle reduction was used directly for the three-hour peak period reduction because the HOV lane would probably be restricted to HOVs only in peak periods when there is congestion in the general purpose lanes. Peak period vehicle reductions range from about 100 vehicles for Mode Combination 1 to almost 2,050 vehicles for Mode Combination 5. The reduction for Combination 5 represents a 9 percent

decrease in the directional design hour volume. Several other combinations produce reductions of 8 percent or so, including Combinations 3, 4, 13, and 14.

Highway Level of Service Analysis

Level of service analyses were conducted for each segment of the I-93 corridor for the 2020 design hour volumes assuming the traffic volume reductions associated with each of the Mode Combinations. The evaluation of the various alternative modes of transportation was designed to determine if use of rail, bus and HOV lanes by commuters could result in fewer trips and, consequently, reduce the number of lanes needed to maintain an acceptable level of service during the design hour. The evaluation of traffic operations, taking into account the possible reductions in vehicle trips, shows that the availability of alternative modes would not reduce the volume of traffic on I-93 to a level where an acceptable level of service could be maintained with fewer travel lanes. Specifically, the various alternative modes of travel would result in little or no reduction in travel on I-93 during the design hour.

These various alternative modes of travel result in little or no reduction in the volume of traffic during the design hour because the level of congestion along the corridor extends well beyond a one-hour period. Currently, commuters routinely experience substantial delays that extend beyond a one-hour period and this situation will worsen over time. Reductions in traffic that would result from the implementation of the various alternative modes of transportation would serve to reduce the period of time in which congestion occurs, but not the level of congestion within the design hour.

A summary of the level of service analyses for all segments of the corridor for each Mode Combination is presented in Table 2.3-6. As shown in the table, none of the mode combinations meet the established criteria of providing at least a LOS D operation over all segments for the 2020 design hour. However, Mode Combination 10, which is the only combination that provides four general purpose lanes, comes the closest to meeting the criteria providing LOS D or better along each segment of the corridor with the exception of the segment south of Exit 1. The four-lane section south of Exit 1 would operate at LOS E.

All other mode combinations show either a LOS E or a LOS F operation along the segments south of Exit 3. In fact, only Mode Combinations 7, 9, and 14, which each provide three general purpose lanes plus an HOV lane in various combinations with bus service, the west rail, and the enhanced rail, were able to obtain a LOS D operation between Exits 1 and 3 for the hour prior to and following the design hour.

Considerations and Implications

Impacts on Traffic Level of Service

The analysis of levels of service on I-93 with various combinations of rail, bus, and HOV options indicates that in 2020 I-93 would continue to operate at deficient levels of service

and would require additional travel lanes to operate at acceptable levels of service. None of the alternative combinations of rail, bus, and HOV options reduces the number of additional travel lanes needed to provide acceptable operating levels of service.

The mode combinations tested were developed to maximize rail, bus, and HOV ridership and the resulting diversion of traffic from I-93. Some of the combinations included no widening of I-93 because ridership on rail, bus, and the HOV lane is maximized when travel times on the highway are greatest. Widening the roadway will decrease delay and reduce the number of drivers diverted to rail, bus, or HOV options. The combinations with the greatest diversion did not result in a reduction in the number of additional lanes needed for I-93 in 2020.

Rail Ridership

The Enhanced Rail Corridor provides service for Boston bound travelers as well as for travelers to major employment centers in northern Massachusetts along I-93. Based on the initial analysis of all the rail options (assuming four travel lanes in each direction on I-93), Enhanced Rail generates the largest number of daily boardings to Boston. It also generates additional daily boardings to northern Massachusetts. In the analysis of mode combinations, the Enhanced Rail generated almost 3,000 daily boardings with only two lanes in each direction on I-93. About 1,260 of these boardings are for trips to downtown Boston.

The major disadvantage of the Enhanced Rail corridor is that it depends on the continuation of the corridor in Massachusetts to the Anderson Regional Transportation Center in Woburn. The preliminary conclusions of the Study Advisory Committee for the I-93 corridor study in Methuen and Andover in northern Massachusetts recommend a joint study by New Hampshire and Massachusetts of rail service between Boston and Manchester.

When analyzed individually, the East and I-93 Basic rail corridors generated the second highest levels of increased daily boardings (half the level of the Enhanced Rail Corridor). Although these ridership levels are lower than the Boston bound riders on the Enhanced Rail Corridor, neither corridor is as dependent on an extensive infrastructure investment in Massachusetts as is the Enhanced Corridor. When analyzed individually, the West Rail Corridor generates the smallest increase in rail boardings of the four rail alternatives. Further, the portion of the West Corridor ridership generated by the Merrimack Station is not expected to divert traffic from I-93. In terms of its impact on I-93 traffic, the West Rail Corridor appears to be the least effective rail option.

Table 2.3-6
2020 Directional Design Hour Volumes (DDHV) and Shoulder Hour Level of Service Summary for I-93 Between I-293 and the Massachusetts State Line Resulting from Bus, Rail and HOV Lane Improvements

	South of Exit 1		Exit 1 to Exit 2		Exit 2 to Exit 3		Exit 3 to Exit 4		Exit 4 to Exit 5		North of Exit 5	
Mode Combination	DDHV[1] LOS[2]	Shoulder Hour[3] LOS	DDHV LOS	Shoulder Hour LOS	DDHV LOS	Shoulder Hour LOS	DDHV LOS	Shoulder Hour LOS	DDHV LOS	Shoulder Hour LOS	DDHV LOS	Shoulder Hour LOS
1 (No-Build w/West Rail)	F	F	F	F	F	F	F	E	F	F	F	F
2 (No-Build w/Enhanced Rail)	F	F	F	F	F	F	F	E	F	F	F	F
3 (No-Build w/Rail)	F	F	F	F	F	F	F	D	F	E	F	F
4 (No-Build w/HOV, Bus)	F	F	F	F	F	F	E	D	F	E	F	F
5 (No-Build w/HOV, Bus, West Rail)	F	F	F	F	F	F	E	D	F	E	F	F
6 (3 Lanes w/Bus)	F	F	F	E	F	E	D	C	D	D	D	D
7 (3 Lanes w/HOV, Bus)	F	F	E	D	E	D	C	C	D	C	D	D
8 (3 Lanes w/Bus, West Rail)	F	F	F	E	F	E	D	C	D	D	D	D
9 (3 Lanes w/HOV, Bus, West Rail)	F	F	E	D	E	D	C	C	D	C	D	D
10 (4 Lanes w/Bus)	E	E	D	D	D	D	C	C	C	C	C	C
11 (2 Lanes w/HOV, Bus, East Rail)	F	F	F	F	F	F	E	D	F	E	F	F
12 (3 Lanes w/HOV, Bus, East Rail)	F	F	E	E	E	E	C	C	D	C	D	D
13 (2 Lanes w/HOV, Bus, East Rail)	F	F	F	F	F	F	F	D	F	E	F	F
14 (3 Lanes w/HOV, Bus, Enhanced Rail)	F	F	E	D	E	D	C	C	D	C	D	D

1 DDHV – Directional Design Hour Volume
2 LOS – Level of Service (see attached sheet for definition)
3 Shoulder Hour – The Hour before and after the Design Hour

HOV Lanes

Recommendations relative to incorporating HOV lanes in the improvements for I-93 are influenced by three factors: projected volume in the HOV lane, provision of an HOV lane in Massachusetts, and impact on total traffic volume on I-93. *National Cooperative Highway Research Program (NCHRP) Report 414, HOV Systems Manual*, recommends a minimum operating threshold of 400 to 800 vehicles per hour per lane for freeway HOV lanes. The minimum operating thresholds are designed to ensure that the facility does not appear to be underutilized to users of the general purpose lanes.

Since all the HOV analyses for I-93 have been based on 2+ HOVs, the 800 vehicle minimum operating threshold appears to be appropriate for the I-93 corridor. Projected peak hour HOV lane volumes with three general purpose lanes in each direction the entire length of the corridor would exceed the 800 vehicle minimum operating threshold only on the segment south of Exit 1. With only two general purpose lanes throughout the corridor (except south of Exit 1 where there are currently three lanes), the segment south of Exit 2 is projected to have a peak hour volume just below the 800 vehicle threshold. With either 2 or 3 general purpose lanes, the smallest minimum operating threshold (400) would not be exceeded north of Exit 5 and would barely be met north of Exit 4. As a result, projected hourly HOV volumes do not meet a minimum operating threshold that would be appropriate for I-93 between Salem and Manchester.

The projected HOV volumes represent approximately 10 to 11 percent of the total peak hour peak direction volume for I-93 between Exit 1 and the Massachusetts State line. This represents an increase over existing conditions. As reported in Section 3.2.1.1, counts conducted in April 2002 on I-93 southbound, south of Exit 1 in the morning peak hour indicate that HOVs currently represent about 8 percent of the total traffic volume.

The volumes projected through the ridership study and mode combinations analysis are based on the assumption that the HOV facility is continued in Massachusetts between the state line and I-95 (Route 128). If there was no Massachusetts facility, the 800 vehicle minimum operating threshold would not be met on any segment of I-93 and the 400 vehicle threshold would be not be met for the segments north of Exit 4. The preliminary conclusions of the Study Advisory Committee for the I-93 corridor study in Methuen and Andover in northern Massachusetts includes a recommendation to widen the roadway with an additional general purpose lane in each direction. An HOV facility is not recommended.

The provision of an HOV lane is designed to encourage the formation of carpools and reduce the number of vehicles on the roadway. Based on the travel time savings expected with an HOV lane that continues into Massachusetts to I-95 and assuming there are three general purpose lanes in addition to the HOV lane, a reduction of approximately 125 vehicles in the peak hour is expected south of Exit 1. This represents

about 1.6 percent of the projected peak hour volume of 7,650 vehicles. Similar or smaller percentage reductions are expected on segments north of Exit 1. These reductions are not large enough to have a discernible effect on traffic congestion in the general purpose lanes. Further, these reductions are based on the provision of an HOV lane in Massachusetts, which is not included in the preliminary recommendations of the Study Advisory Group for the study of I-93 in northern Massachusetts.

Bus Ridership

The analysis of the Expanded Bus service showed that an HOV lane in both Massachusetts and New Hampshire substantially increased bus ridership. An HOV lane in New Hampshire-only had little effect on ridership. The analysis of individual options also included consideration of a bus fare subsidy comparable to the fare subsidy that would be provided to rail users under the current MBTA fare structure. The subsidy increased daily bus boardings by 250 to 270.

The largest bus ridership projection is 2,840 daily boardings with Mode Combination 5. Mode Combination 5 includes an HOV lane, bus subsidy, Expanded and Enhanced bus service, and the West Rail Corridor. The projected ridership is somewhat less than the 3,000 daily boardings projected for the Enhanced Rail (Mode Combination 3). The inclusion of an HOV lane appears to have the most influence on bus ridership, increasing the ridership volume by 600 to 700 riders for mode combinations with HOV lanes versus those that do not have HOV lanes.

The projections of ridership for various bus options does not include an estimate of the number of buses needed to carry the projected ridership. Of particular concern is the capacity of existing bus docking space at the South Station bus terminal.

Related Issues

In addition to the conclusions presented above, several related issues need to be considered:

- The ridership projections for the most part are based on traffic expected during peak commuter hours. The various modes analyzed in the ridership projections would not generally serve tourist or recreational traffic which is an important factor in travel on I-93.

- The ridership projections do not address or account for safety deficiencies associated with the existing highway.

2.3.5.6 Summary and Conclusions

The preliminary analysis of the eight mode options presented above provided an understanding of the potential of each and a focus for further development of individual mode options as well as development of combinations of mode options. The analysis

indicated that ridership volumes for the I-93 Basic Rail option would be similar to that for the East Rail option, and consequently subsequent analyses did not test the Basic Rail option. Similarly, the New Hampshire-only HOV lane does not produce sufficient ridership on buses or in carpools to warrant further testing of this option.

Subsequent studies were conducted to evaluate the mode options in combination with each other and with various highway widening alternatives, to both test the ridership that might be generated, as well as to project the resulting level of service of the highway given the ridership generated. In this way alternative modes were evaluated on their merits, and the need for widening I-93, and to what degree, was also tested.

2.4 Initial Screening of Alternatives

This section summarizes the process to screen the conceptual alternatives. The process involved evaluating conditions along the corridor, considering resources potentially subject to impact, considering issues of concern to communities and the public, and evaluating existing and potential alternatives. The rationale for eliminating certain alternatives from further study is explained, followed by the identification of a "reasonable range of alternatives" (Section 2.5).

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2.4.1 Resource Agency Meetings

In order to facilitate the development and later initial screening of alternatives, a number of meetings were held by the NHDOT with the various Federal, State and local project stakeholders. Information which progressed from conceptual ideas through eventual plans, analysis and reports was presented or distributed to the various agencies or to the general public in attendance.

The NHDOT and the FHWA are the state and federal agencies responsible for technical oversight and development of the EIS for the I-93 project. Together, these agencies provide for the technical review for this project, particularly in the case of transportation issues. In addition, technical review and input is sought from the Federal Transit Administration, Regional Planning Commissions, and technical staff that reside with the local communities. Technical review activities served as a preliminary forum to consider all project related materials, ideas and design concepts developed. These technical review meetings were held as required, throughout the life of the project, to review project related information and solicit input. In turn, revisions were made or additional studies were conducted, as appropriate, to supplement the study process.

Another level of review includes both federal and state environmental Resource Agencies. These agencies are responsible for making or influencing permitting decisions based on state and federal laws and regulations, and ultimately serve to

protect natural, cultural, and socio-economic resources potentially affected by the project. The agencies are focused on assuring the least impacts, while providing a practicable solution that meets the project purpose and need.
State resource agencies involved in this project include:

State Agency	State Level Responsibility
NH Department of Environmental Services	Wetlands, Air Quality, Water Quality
NH Natural Heritage Inventory	Threatened or Endangered Plant Species
NH Division of Historical Resources	Historical and Archeological Resources
NH Office of State Planning	Floodplains, Land Use Planning
NH Office of Emergency Management	Floodplains
NH Fish & Game Department	Fisheries, Wildlife, Threatened or Endangered Wildlife Species

Federal resource agencies involved in this project include:

Federal Agency	Federal Level Responsibility
US Environmental Protection Agency—Region 1	Wetlands, Air Quality, Water Quality
US Army Corps of Engineers – N.E. District	Wetlands, Water Quality, Historic and Archeological Resources, Floodplains
US Fish & Wildlife Service	Fisheries, Wildlife, Threatened or Endangered Species
Federal Emergency Management Agency	Floodplains

The I-93 project has been identified as a high priority project by the NH State Legislature via HB1106 because of the importance of this highway corridor to the region and the State. In addition, the tenets of environmental streamlining, as outlined in TEA-21 federal legislation, were followed in an effort to streamline the environmental permitting process, so that improvements could be constructed and implemented as soon as possible.

As an outgrowth of the streamlining process and in conjunction with the public participation program, the Resource Agency meetings for this project, normally held at NHDOT headquarters in Concord, were held in the communities along the project corridor. Information related to the study was presented and distributed at these meetings. The meetings were open to the general public and public participation is encouraged through public notice. Additional meetings have also been held with the Resource Agencies as part of the streamlining process. These meetings also resulted in revisions or additional studies, as appropriate, to address comments solicited from these agencies.

A total of twenty-one Resource Agency meetings have been held to date with seven additional meetings held to establish and coordinate the Environmental Streamlining

process. Actual dates and locations of these meetings are listed in Chapter 8 of this report along with the topics of discussion.

An Advisory Task Force (ATF) was established early in the project process. The I-93 ATF is made up of thirteen people consisting of two people, representing each of the five communities through which I-93 passes, and one person appointed by each of the three Regional Planning Commissions, whose regions are affected by the project.

ATF meetings were held on a regular basis early in the public participation process to present and distribute project related information. The meetings were held in the evenings, and were open to the general public, with public participation encouraged. Over time, the meetings evolved into public informational meetings with discussions principally focused on issues of concern to the community in which the meeting was being held.

In total, 12 ATF meetings were held within the five communities along the corridor. Actual dates and locations of these meetings are listed in Chapter 8 of this report along with the topics of discussion.

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2.4.2 Public Officials and Public Informational Meetings

Meetings with local and regional, appointed and elected public officials of the five communities directly affected as well as the general public were held periodically to review project findings, status, and schedule. The meetings are held in the evenings. In general, Public Officials Meetings are held to review project-related information and solicit input. Revisions and additional studies, as appropriate, are conducted to address comments received.

Two rounds of public officials meetings have taken place for this project. A first series of meetings with each of the five communities were held in March, 2000 to initiate the public participation process and present the study area for the corridor and discuss the issues of concern and alternatives to be studied.

During the months of November and December, 2000, a second round of meetings were held in the communities to discuss study findings relative to alternative modes of transportation and present the concept plans for widening the highway and improving the interchanges.

In all, eleven Public Officials Meetings have been held to date within the five communities along the corridor. Actual dates and locations of these meetings are listed in Chapter 8 of this report along with topics of discussion.

Public Informational Meetings are similar in format, agenda and intent as the Public Officials Meetings, although the emphasis for the latter is to obtain feedback from community officials, while for the former is to disseminate information and obtain

feedback from all interested parties. Typically the Public Informational Meetings have been held in series of five (one meeting per corridor community) and in total, 15 Public Informational Meetings have been held.

The first round of Public Informational Meetings was held between July and September, 2001 to discuss the various options developed and present more detailed concept plans. A second round of Public Informational Meetings was held in November and December, 2001 to review updated plans and critical issues. A third round of Public Informational Meetings was conducted in June/July 2002 to discuss the NHDOT's Preferred Alternative and other outstanding issues.

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2.4.3 Environmental Constraints

In developing the conceptual alternatives, environmental (natural, cultural, and socio-economic resources) and engineering constraints were considered. Environmental data based on available mapping, project research, agency contacts, and field investigations as outlined in the *Scoping Report* (VHB 2000) were used to identify resource constraints. The conceptual layouts of the I-93 mainline and interchange alternatives attempted to first avoid environmental resources within the engineering constraints of widening the existing I-93 corridor. That is, the mainline alignments were shifted to the east or west, within interstate geometric design and constructability parameters, to avoid or at least minimize impacts to important resources and properties. Areas that exhibited substantial or unmitigatable impacts were noted.

Concepts were viewed at a macro level and the designs were essentially two-dimensional in nature, except at certain locations where critical cross sections were developed to better understand the potential impacts and engineering issues. Resource impacts were not quantified but instead were visually compared to see whether one concept would probably have greater impacts than another. Resources that were considered important environmental constraints influencing the conceptual design and selection of alternatives included the following:

Surface Water Resources

The Canobie Lake Watershed was a particular concern, in part because the Lake serves as Salem's water supply. In addition, the Cobbetts Pond watershed was of concern as an important recreational resource in the Town of Windham. Other lakes, ponds, and streams were a concern relative to water quality, with many of the area waterbodies and watercourses having recreational and other values to the communities in the region.

The potential for stormwater delivery of pollutants to surface waters is a general concern throughout the I-93 corridor. In particular, Canobie Lake, a Class A waterbody serving as the water supply to the Town of Salem, and Cobbetts Pond are potential receptors of non-point inputs of road runoff due to their proximity to the

corridor. In addition to the potential for non-point inputs to these lakes, there are tributaries to these waterbodies that serve as potential pathways for delivery of drainage derived from an extensive section of I-93.

Floodplains

Conceptual alternatives were screened for their effect on the floodplain areas that exist within the five communities through which I-93 passes.

The Spicket River and its tributaries (particularly Porcupine Brook and Policy Brook with their proximity to I-93) in the Town of Salem was of special concern relative to flooding because of a history of flooding problems both within the study area (in New Hampshire) and in downstream communities in Massachusetts. Flood impacts along this river system extend from Salem to Methuen and Lawrence, Massachusetts. What is referred to as "primary valley storage" is provided along the section of this river that parallels I-93 near the Massachusetts border. This storage could be affected by widening the highway.

Beaver Brook in the Derry/Londonderry area and Cohas Brook, in Manchester also have floodplains and floodways that may be directly affected by improvements to the existing highway.

Groundwater

Most public and community water supplies fall outside the immediate corridor of the existing highway. However, the potential for road salt contamination of nearby wells was a general concern throughout the I-93 corridor. Additionally, there are a number of specific locations where protection of groundwater was an issue. These included the following locations:

- Windham community water supply well between Canobie Lake and I-93
- Proximity to Canobie Lake (Class A water body serving as water supply for the Town of Salem) and surrounding watershed
- The joint Wellhead and Watershed Protection Areas established by the Towns of Salem and Windham.
- The Groundwater Resources Conservation District established by the Town of Derry.

Air Quality

Air quality remains a primary consideration. The alternatives carried forward should not exacerbate the existing violation of carbon monoxide (CO) standards and ought to improve upon it. Similarly for ozone, the alternatives must be compatible with other

regional projects and trends so as to not increase, and preferably decrease, regional emission of ozone precursors.

Noise

Changes in traffic noise levels were a concern for a number of neighborhoods in close proximity to I-93. To the extent practicable, widening layouts were developed to maintain offsets to neighborhood areas and, if this were not possible, the practicality of erecting sound walls was considered.

Wetlands

Wetlands were recognized to be an important resource for which impacts had to be avoided to the extent practicable. Those wetland impacts that could not be avoided had to be minimized and mitigation provided. Wetlands that were considered particularly important were those associated with Porcupine Brook in Salem, a heron rookery near the southbound weigh station in Windham, an extensive wetland system just north of Lowell Road on the west side of the highway also in Windham, Wheeler Pond in Londonderry, a large unnamed pond and associated emergent marsh just north of Exit 5 in Londonderry, and the wetland system along Cohas Brook in Manchester.

Avoidance of substantial impacts to NH designated "Prime Wetlands" at the local level as well as vernal pools was also a goal. Wetlands designated as prime carry special consideration relative to impacts and mitigation. Prime wetlands potentially impacted by the I-93 improvements are located in Salem and Derry.

Vegetation and Wildlife Habitat

Concerns relative to wildlife along the I-93 corridor principally involved consideration of minimizing impacts to wildlife habitat to the extent practicable. Specific areas of interest included the marsh at the junction of I-293 and I-93 (an important habitat for waterfowl, wading birds, and aquatic mammals); the riparian wetland system along Cohas Brook, and the great blue heron rookery near the southbound weigh station in Windham.

Socio-economic Impacts

Socio-economic impacts include direct impacts to people's homes, businesses, and work places, and indirect impacts affecting access, land use, setting, travel patterns, safety, and local and regional economies. For the most part, direct impacts create hardships and need to be avoided or minimized to the extent practicable. Indirect impacts are more difficult to estimate and evaluate, and can result in benefits or problems that are long-term in nature. Socio-economic issues of primary concern involved minimizing impacts to private property, while incorporating into the proposed layout enough planning to assure the I-93 corridor can continue to service the transportation needs of the region long into the future. Interchange areas generally contain relatively dense commercial/industrial development that typically constrains

designs. Neighborhoods elsewhere on both sides of the mainline also pose a serious challenge relative to avoiding or minimizing impacts.

Cultural Resources

Archaeological Sites and Historic Architectural Properties

Archaeological sites and historic properties are scattered along and within the highway corridor the length of the project. Areas of both prehistoric and historic archaeological sensitivity occur in many locations along the corridor and were viewed as constraints in developing alternative concepts for highway improvements. Typically such areas should be avoided where possible. If impacted, additional research and recovery are required. Similarly extant historic properties and buildings that are potential constraints are located in Salem along the easterly Cross Street approach to I-93; in Windham along NH 111 immediately west of I-93, along NH 111A in the median area of I-93 south of Exit 3 and east of I-93 just north of Exit 3; in Londonderry , the Ash Street/Pillsbury Road Bridge, the Woodmont Orchards north and west of Exit 4, and along Stonehenge, Rockingham and Perkins Roads; and the Pumping Station east of I-93 along Cohas Avenue in Manchester. Again, such areas needed to be avoided if possible, and, if not, measures to mitigate the impacts developed.

Public Lands

Public lands of particular concern would be those that fall under the Section 4(f) and Section 6(f) purview. Section 4(f) of the Department of Transportation Act of 1966 states "… special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges and historic sites." There are several Section 4(f) land parcels within, and surrounding the I-93 study area.

Section 6(f) lands are defined as lands that have been acquired or improved with funds provided by the federal Land and Water Conservation Act. Two properties located in the I-93 study area qualify as Section 6(f) properties: Hedgehog Park in Salem and Crystal Lake Park in Manchester. Based on preliminary review of the proposed conceptual highway improvements, it was concluded that these properties could be avoided.

Secondary and Cumulative Impacts

Secondary growth was a major issue of concern among some resource agencies given the potential for stimulating further development in New Hampshire as a result of improving the I-93 corridor to accommodate more traffic. Some secondary development within New Hampshire and Massachusetts resulting from improvements to I-93 are anticipated.

Cumulative impacts may involve improvements to NH 111 through Windham and Salem, the Exit 4A Interchange in Londonderry and Derry, the Airport Access highway in Merrimack, Bedford, Manchester, and Londonderry and the continuing expansion of

the Manchester Airport. Cumulative impacts could also involve improvements to I-93 in Massachusetts that are currently being considered as part of the Traffic Corridor Study of I-93 from Andover north to the New Hampshire line initiated by the Merrimack Valley Regional Planning Commission (MVPC) in Massachusetts.

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2.4.4 Initial Screening Traffic and Highway Operational Considerations

From an operational perspective, a first step in considering alternatives is to determine the number of basic lanes that would accommodate future travel demand along I-93. The basic lanes of a highway are the travel lanes that are needed solely to accommodate the movement of through traffic. Basic travel lanes do not include traffic management lanes such as climbing lanes, acceleration/deceleration, weaving, and merging type lanes, which may be needed in the vicinity of an interchange to accommodate vehicles entering and exiting the highway. These basic lanes serve to provide a consistent number of lanes over a substantial length of highway.

The results of this analyses of strictly operational needs indicate that to provide at least a LOS D operation in 2020 would require the following number of basic lanes along the corridor.

- 10 lanes (5 lanes in each direction) south of Exit 1,
- 8 lanes (4 lanes in each direction) between Exit 1 and Exit 3, and
- 6 lanes (3 lanes in each direction) between Exit 3 and I-293.

Again, these basic lane requirements are the number of basic lanes, exclusive of traffic management lanes, that are needed to accommodate through traffic along the each segment of the I-93 corridor. Note that to provide a LOS D operation along the segment south of Exit 1 would require a ten-lane section. This exceeds the NHDOT's general guideline of not constructing highways with more than eight basic lanes (four lanes in each direction).

In addition to determining the number of basic travel lanes, the evaluations of alternatives included a traffic operations analysis for each of the modes that might address the corridor needs. In general the capacity of a freeway type lane is reached when the volume of traffic approaches approximately 2,200 vph. Volumes above 2,200 vph cause the time of congestion to lengthen into the hour before and after the peak hour congestion. The level of service analyses have been conducted for each segment of the I-93 corridor for the 2020 design hour volumes.

The evaluation of the various alternative modes of transportation, as presented in the previous section, provides ridership estimates for alternative modes such as rail and bus, and usage estimates for an HOV lane. Use of rail, bus and HOV lanes by commuters would result in fewer vehicle trips on the I-93 corridor and, consequently

could reduce the number of lanes needed to maintain an acceptable level of service during the design hour.

The subsequent evaluation of traffic operations, taking into account the possible reductions in vehicle trips due to the availability of alternative modes of travel, shows that the availability of alternative modes would not reduce the volume of traffic on I-93 to a level where an acceptable level of service could be maintained with fewer travel lanes than the basic requirements proposed above. Specifically, the various alternative modes of travel would result in little or no reduction in travel on I-93 during the design hour.

These various alternative modes of travel result in little or no reduction in the volume of traffic during the Design Hour because the level of congestion along the corridor currently extends beyond a one hour period and this situation will worsen over time through the 2020 design year. Currently, commuters routinely experience substantial delays that extend over a three-hour period. Therefore, the reductions in traffic that result from the various alternative modes of transportation actually occur at the outside of the commuter period rather than during the design hour. In other words, the use of other modes of transportation would serve to reduce the number of hours of congestion, but not the level of congestion within the design hour.

A summary of the level of service analyses for each segment of I-93 between the Massachusetts state line and I-293 is presented in Table 2.3-6. The table includes the levels of service for both the directional design hour and the hour immediately before or after the directional design hour (i.e., shoulder hour). In doing so, the merits of any particular mode combination for a particular segment can be better evaluated. For example, if the level of service remains the same both in the directional design hour and the shoulder hour, then the mode combination has a more marginal effect on addressing the needs of the highway. If the shoulder hour has a better level of service, then the mode combination shows more potential for addressing the highway needs of the particular segment.

As shown in the table, none of the mode combinations meet the established criteria of providing at least a LOS D operation over all segments for the 2020 design hour. However, Mode Combination 10, which is the only combination that provides four general purpose lanes, comes the closest to meeting the criteria as LOS D or better is provided along each segment of the corridor with the exception of the segment south of Exit 1. The four-lane section south of Exit 1 would operate at LOS E. This result is consistent with the previously stated finding that 5 lanes in each direction would be needed south of Exit 1 to maintain a LOS D.

All other mode combinations show either a LOS E or a LOS F operation for the 2020 Design Hour along the segments south of Exit 3. In fact, only Mode Combinations 7, 9, and 14, which each provide three general purpose lanes plus an HOV lane in various combinations with bus service, the west rail, and the enhanced rail, were able to obtain

a LOS D operation between Exits 1 and 3 for the hour prior to and following the design hour.

The following conclusions were drawn from the results of the alternative mode of transportation evaluation.

- The various transit and HOV options, either alone or in combination, do not reduce the number of additional travel lanes required to provide acceptable levels of service on I-93

- The most effective transit options in terms of the net diversion of vehicles from I-93 are the Enhanced Rail Corridor or the provision of an HOV lane with Expanded and Enhanced bus service. The Enhanced Rail Corridor generates the highest level of ridership of all the transit options. The combination of Enhanced and Expanded bus service with an HOV lane generates almost as much ridership as the Enhanced Rail Corridor. The net diversion for each of these alternatives is approximately the same.

- The Enhanced Rail Corridor requires extensive infrastructure improvements in Massachusetts along the I-93 corridor to provide service to major employment centers and the Anderson Transportation Center in Woburn. The MVPC study of the I-93 corridor in Methuen and Andover Massachusetts considered several options for rail service in Massachusetts. Although the study report is not finalized, the preliminary recommendations of the Study Advisory Committee call for improvements to the Haverhill commuter rail line to allow increased service and a cooperative study by New Hampshire and Massachusetts of potential options for rail service between Manchester and Boston.

- To be effective, an HOV lane in New Hampshire must be extended into Massachusetts and would require an extensive infrastructure investment along the I-93 corridor in northern Massachusetts. The MVPC study of the I-93 corridor in Methuen and Andover Massachusetts considered an HOV lane option. Although the study report is not finalized, the preliminary recommendations of the Study Advisory Committee call for widening the roadway to four general purpose lanes in each direction and do not include the provision of an HOV facility.

- The East and I-93 Basic Rail corridors generate between one-third and one-half the ridership of the Enhanced Rail Corridor depending on the number of travel lanes on I-93. However, these alternatives require much less infrastructure investment in Massachusetts than does the Enhanced Rail Corridor.

- The West Rail Corridor would have a less effective influence in addressing traffic issues along I-93.

- An HOV lane in New Hampshire-only does not generate HOV volumes that meet the recommended minimum operating threshold.

- An HOV lane in Massachusetts and New Hampshire generates HOV volumes that meet the recommended minimum operating threshold only south of Exit 1.

- Providing an HOV lane in Massachusetts and New Hampshire increases bus ridership substantially over having no HOV lane or an HOV lane only in New Hampshire.

- As noted above, a rail alternative does not reduce the number of lanes required to address existing and future traffic needs. With that said, the widening of I-93 to more than four lanes in each direction will not be acceptable, and future capacity needs will have to be served by other facilities or modes of transportation. Therefore, it would appear to be important to reserve space within the highway corridor that can be utilized in the future as required.

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2.4.5 Conclusions from Initial Screening

Conclusions from the above described screening can be summarized as follows:

No-Build

The No-Build Alternative is not considered a viable alternative relative to the project purpose and need, but will serve as a baseline condition for comparison with other alternatives. The No-Build Alternative involves accepting the deteriorated condition of the infrastructure, increased congestion, and decreased safety, a seemingly untenable situation.

Highway Widening

The initial highway widening concepts incorporated a typical roadway cross section, which included four 12-foot travel lanes, a 10-foot outside shoulder, a 14-foot inside (HOV enforcement) shoulder and a 4-foot painted buffer area between the two inner most travel lanes, in each direction. The inner most travel lane could be utilized as an HOV lane. This typical cross section was mirrored in the opposite direction for a total of 8 lanes or 4 lanes in each direction. The minimum median width between the two northbound and southbound barrels varied between approximately 60 feet to 90 feet, so as not to preclude the potential for a future rail line down the median.

As previously noted, an HOV facility would not produce the minimum recommended ridership to make these lanes a feasible option. It was therefore recommended that the HOV lane option be dropped from further consideration. This would result in a reduction in width of 6 feet in each direction, or a total of 12 feet in the overall corridor width. With that said, the extra 6 feet in each direction was carried forward with all widening layouts to provide sufficient flexibility to finalize the selected design, address constructability issues, and so as to not preclude the possibility of instituting HOV

lanes in the future should Massachusetts incorporate them or the practicality of such lanes become apparent in the future.

Mainline Improvements

The I-93 mainline improvements were carried forward for additional evaluation. Three different widening concepts were developed between Exits 1 and 2 to minimize or avoid impacts to Porcupine Brook:

- Concept 1 – constructing a new northbound barrel to the east, widening the southbound barrel to the west and providing for a future rail line on the existing northbound barrel,

- Concept 2 – widening the existing northbound barrel to the east, widening the southbound barrel to the west and providing for a future rail line within the median, and

- Concept 3 – widening the existing northbound barrel to the east, widening the southbound barrel to the west and providing for a future rail line to the west,

Of these only Concept 2 was selected to be carried forward for more detailed evaluation. By observation, this concept had the least impacts assuming the rail line would be supported on a trestle system.

The remaining I-93 mainline concepts carried forward and evaluated in more detail minimize or avoid impacts to important resources, while at the same time providing practicable alignments both in terms of construction and long term operation.

Interchange Improvements

In addition, the following I-93 interchange improvements were selected for further evaluation:

- Exit 1 Options- **(Figure 2.3-24)** Both concepts were carried forward and evaluated further.

- Exit 2 Options – **(Figure 2.3-25)** Both concepts were carried forward and evaluated further.

- Exit 3 Options-(**Figures 2.3-26 through 2.3-30)** All nine concepts were carried forward and evaluated further except for the design concept developed for Exit 3 in 1995, as part of the Windham-Salem NH 111 (10075) project, which included a flyover ramp. This concept was not carried forward, as other options evaluated provide satisfactory levels of service with fewer impacts.

- Exit 4 Options – **(Figures 2.3-33 and 2.3-34)** Both concepts were carried forward and evaluated further.

- Exit 5 Options- **(Figure 2.3-35)** All three concepts were carried forward and evaluated further.

TDM Measures

TDM measures, with the exception of Congestion Pricing, were carried forward for more detailed evaluation. Congestion pricing was not proposed for further study as it would do little to address current congestion levels, there is a lack of alternative routes or modes, and it would likely be viewed as a regressive tax and incompatible with New Hampshire's quality of life.

Proposed construction of park-and-ride lots at Exits 2, 3 and 5, along with continued use of the existing lot at Exit 4, were also carried forward. A number of concepts were developed and refined, as appropriate, to minimize impacts and maximize use, and to evaluate alternative sites for a particular interchange.

Mode Options – Rail, Transit

Based on the study of potential ridership and its affect on highway level of service, bus service, rail service and the use of HOV lanes, either alone or in combination with each other, do not eliminate the need to widen the highway, if acceptable levels of service are to be achieved over the next 20 years, or even over the intermediate time frame of 2010. The mode options will help alleviate the length of time over which congestion occurs, but the peak hour of congestion will remain, and under many of the mode combinations tested, the 3+ hour period of congestion will remain. With this in mind, it was concluded that further consideration of HOV lanes and rail service be discontinued as part of this project. These measures do not result in enough diversion to influence the need to widen the highway and would result in major additional expenditures for construction and long term operation. They also require substantial investment by the State of Massachusetts.

Improvements in bus service in the form of expanded bus service, and enhanced ride-sharing opportunities were proposed for further evaluation. In addition, given the likelihood that rail service will be required to meet the long-range needs of transportation in the area served by I-93, it was proposed that space be reserved within the I-93 highway corridor for a possible future passenger rail line. By reserving such space, future opportunities for rail service, and possibly as an interim measure for bus service, will remain available. In addition, NHDOT has committed to conducting a study with the Commonwealth of Massachusetts to evaluate long-term transit alternatives between Boston, MA and Manchester, NH. NHDOT is currently working with MEOTC to develop a scope of work and process by which the study will be conducted. Funding has been secured at the federal level, a scope of work has been determined and the consultant selection process has been initiated. The study is scheduled to begin in 2004, and will be the first step in implementing a plan to substantially improve transit options for the area currently served by I-93 from Manchester, NH to Boston, MA.

2.5 Identification of a Reasonable Range of Alternatives

Based on the collective consideration and analysis described in Section 2.4, the following seven alternatives or combination thereof were selected as a "reasonable range of alternatives" for more detailed evaluation in this DEIS (see Chapter 4.0):

1. The No-Build Alternative, which essentially serves as the baseline condition for comparison with the Build Alternatives.

2. Transportation Systems Management (TSM) measures; specifically minor improvements such as ramp lengthening and lane widenings that can be accomplished within the existing ROW at minimal expense. Such measures generally do not address the long-term project purpose and need, but can help to alleviate problems in the near term. Two other TSM measures, ramp metering and shoulder lane use, were determined to be impractical and were not proposed for further consideration.

3. Widening I-93 to 4-lanes in each direction the entire length of the corridor including interchange improvements, in addition to constructing or expanding park-and-ride lots at Exits 2, 3, 4, and 5, and providing room and, as practical, constructing sub-grade for future rail transit service within the highway corridor.

4. Widening I-93 to 3-lanes in each direction for the entire length of the corridor including interchange improvements, in addition to the same park-and-ride lot construction and provision for future rail transit service as noted with the 4-lane widening alternative.

5. Widening I-93 to 4-lanes in each direction south of Exit 3 and 3-lanes in each direction north of Exit 3 including interchange improvements, along with the provisions proposed with either the 3 or 4-lane widening schemes. This is the so-called "Combination Alternative".

6. Transportation Demand Management (TDM) measures; specifically Intelligent Transportation Systems (ITS) techniques as well as employer based measures utilizing incentives and disincentives to encourage people to not drive alone. It was concluded that congestion pricing, another TDM measure, would be impracticable.

7. Improvements in bus service to include expanding existing service and providing enhanced ride-sharing opportunities to employment centers in northern Massachusetts. After ridership studies, it was concluded that neither rail service nor HOV lanes would be effective alone or in combination with other mode options in satisfying the need for the project.

2.6 Comparison of Alternatives

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2.6.1 Environmental Consequences

Detailed descriptions of the impacts associated with the various project alternatives are presented in Chapter 4. A brief summary is presented below and in **Figures 2.6-1 and 2.6-2**.

The No-Build Alternative serves as the baseline condition for comparing impacts of the three- and four-lane widening alternatives. In general, future impacts would be avoided (e.g., losses of wetlands or impacts on historical resources) or at least not further exacerbated (e.g., noise impacts) with selection of the No-Build Alternative. In some cases, the quality of an environmental resource may improve , e.g., pollutant loading to streams is expected to decrease with the Build Alternatives due to more-advanced treatment measures for highway runoff which would be incorporated into the highway's design.

There will be no exceedance of State or Federal carbon monoxide (CO) standards with either the Three- or Four-Lane Alternatives. At the mesoscale level, both alternatives would be in compliance with the 1990 Clean Air Act Amendment and the New Hampshire State Implementation Plan.

From a surface water quality standpoint, the Three-Lane Alternative with the proposed treatment measures will result in 19 of the 21 streams having lower or no net increase in pollutant loading with two streams showing a slight increase as compared to today's conditions. In comparison, with the Four-Lane Alternative, 17 streams will show lower or no net increase in pollutant loading with four streams showing a slight increase. The new park-and-ride facilities at Exits 2, 3 and 5 and the construction of a new terminal building at the existing park-and-ride lot at Exit 4 would have only minor effects on surface water quality.

Relative to groundwater resources, the Three Lane Alternative, including new park-and-ride lots, the new roadway will overlay an additional 58 to 70 acres of stratified-drift aquifer as compared to the existing condition or No Build, while the Four-Lane Alternative overlays an additional 72 to 83 acres. Impacts (included in these totals) associated with the alternative new park-and-ride lots at Exit 5 vary from 0 (Perkins Road) to 13 acres (Auburn Road). With regard to potential well impacts, both the Three-Lane and Four-Lane Alternatives put the new roadway slightly closer to five community wells in the Exit 3 area, although one option, i.e., Tight Shift, moves the highway further away from a large community well (adding to its protection) near the west end of Canobie Lake. At Exit 4, both widening alternatives, are (as is the existing highway), within the wellhead protection area of a community well.

The Three-Lane and Four-Lane Alternatives, including the park-and-ride lots, affect 41 to 44 acre-feet of the 100-year floodplain. Approximately 5 to 6 acre-feet of floodway (i.e., stream or river channel) are affected by both alternatives.

Active farmland is affected only in the Exit 1 and Exit 4 areas. Less than one-half acre is affected by either widening option at Exit 1, while at Exit 4 the westerly widening option could impact up to 9 acres of the Woodmont Orchard. Impacts to important farmland soils vary from 9 to 11 acres for the Three-Lane Alternative and 10 to 12 for the Four-Lane Alternative, including park-and-ride lots.

Wetland impacts for the Three-Lane Alternative vary between 53 and 71 acres depending on the options and park-and-ride lots selected, while the Four-Lane Alternative affects 62 to 82 acres. The impacts of the new park-and-ride lots contribute between 0.4 to 3.2 acres to these totals depending on the options selected. Both alternatives also affect 1 to 3 vernal pools, which are essential breeding habitat for certain types of salamanders and wood frogs, depending on the particular options selected. Total upland and wetland habitat impacts are expected to range from 190 to 240 acres for the Three-Lane Alternative and 210 to 260 acres for the Four-Lane Alternative. Some restoration of this habitat will occur with re-landscaping of the highway edges after construction. The proposed mitigation involving both wetland creation and land preservation is intended to offset these habitat impacts.

Only one known location of a state-threatened plant species, a lupine wildflower, is affected by either widening alternative. The New England cottontail, a possible candidate for Federal threatened or endangered status, was not located in the project corridor during a winter 2002-2003 field study.

For either the Three or Four-Lane Alternatives, noise analysis indicates that 316 sensitive receptors will experience noise levels approaching or exceeding FHWA Noise Abatement Criteria after the project is built. This compares to 265 under the future No-Build condition. Sound walls have been proposed where practicable based on effectiveness and cost.

From a cultural resources standpoint, the Three-Lane Alternative depending on options selected will affect 4 to 8 historic properties eligible for the National Register, while the Four-Lane Alternative will affect 4 to 9 historic properties. Potential mitigation measures for these resources are suggested in Section 4.10.2.4. In addition, 20 to 23 archaeological sites may be affected by either alternative.

Both widening alternatives are expected to reduce local tax bases by $8.3 to $15.4 million. The resultant effect on each community's tax revenue varies with the actual tax rate in each. The total number of business acquisitions is the same for both the Three-Lane and Four-Lane Alternatives (including the park-and-ride lots), and varies from 9 to 18. The number of residential acquisitions is also the same for both alternatives and ranges from 18 to 23 depending upon the design options selected. Stimulation of growth, i.e., secondary growth, may result in an additional 41,000

people and 22,000 jobs within the region influenced by this segment of I-93 by the year 2020. No community facilities including schools, parks, or other structures, are impacted by any of the proposed highway improvements.

With either the Three-Lane or Four-Lane Alternative, some 10 to 13 properties impacted will require further investigation relative to the possibility of encountering contamination from hazardous materials.

Since the project's major purpose is to provide a more efficient flow of traffic, with less congestion during peak commuting hours in particular, the proposed improvements will result in future fuel conservation, as compared with the expected future use under the no-build condition. Offsetting some of this future energy conservation will be the increased energy demands associated with the greater maintenance requirements for the widened highway.

2.7 Selected Action

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2.7.1 Description of Selected Alternative

Based on an evaluation of the Reasonable Range of Alternatives for the project and with input from the State and Federal Resource Agencies and corridor communities, with more than 50 meetings (see Section 8.0) having been held, NHDOT and FHWA identified a Selected Alternative. Feedback from the local communities suggested that NHDOT should 1) construct four lanes in each direction, and not three, the entire length of the corridor from Salem to Manchester; 2) minimize impacts to private properties; 3) construct sound walls; and 4) begin construction as soon as possible.

The Resource Agencies have recognized the need to address I-93 and have concurred with the project purpose to improve the efficiency and safety of the corridor. They have also agreed that the Build Alternatives identified in Section 2.5 were a reasonable range of alternatives, from which, based on additional study, a preferred alternative could be selected. They have noted that the direct impacts to the natural resources should be avoided and/or minimized to the extent practicable, and mitigation provided to offset impacts. Several of the Resource Agencies also requested that NHDOT go forward with an in-depth, two-state study of future transit service. They requested the study take place as soon as possible given the long lead-time involved in instituting such a service.

In response to this input and in order to address the Purpose and Need of the project, the NHDOT's Selected Alternative involves a combination of transportation infrastructure improvements and strategies for the 19.8-mile study corridor. The main element of the improvement involves widening I-93 from the existing limited access two-lane highway in each direction to a limited access four-lane highway in each

direction. The Four-Lane Selected Alternative begins in the Town of Salem, NH at the Massachusetts/New Hampshire State line and extends northerly through Salem, Windham, Derry and Londonderry, and into Manchester, ending at the I-93/I-293 interchange **(Figures 2.7-1 through 2.7-22)**. In addition, the NHDOT has also selected the following design modifications and infrastructure improvements for the five interchanges and local roads within the project corridor:

- In the Exit 1 Interchange area, the existing Cross Street bridge will be replaced with a new bridge located just to the north. The existing interchange at Exit 1 will be reconstructed to improve the substandard ramp geometry. **(Figure 2.7-2)**

- At Exit 2, the existing interchange is reconstructed to a diamond-type interchange configuration. Pelham Road will be widened and reconstructed from Policy Road to Stiles Road **(Figure 2.7-4)**. Just north of Exit 2, the Brookdale Road bridge will be replaced on-line, utilizing a temporary bridge for maintenance of traffic during construction. **(Figure 2.7-5)**

- In the Exit 3 Interchange area, both the northbound and southbound barrels of I-93 are relocated (referred to as the Tight Shift Option) into the median area **(Figures 2.7-6 through 2.7-7)**. The interchange ramps will be reconfigured with a diamond interchange design **(Figure 2.7-7)**. NH 111 will be reconstructed and widened with the work beginning just west of the NH 111/NH 111A intersection. As NH 111 proceeds to the west, NH 111 is relocated (off-line option) north of its existing location before tying into existing NH 111 near the NH 111/Wall Street intersection. **(Figures 2.7-7 through 2.7-9)** NH 111A will be relocated on new alignment west of existing NH 111A **(Figure 2.7-7).**

- In the Exit 4 Interchange area, I-93 will be widened to the east, retaining the existing layout for the southbound ramps. The existing northbound ramps diamond configuration at the northbound ramps will be reconstructed, with longer ramps. NH 102 will be reconstructed and widened from Londonderry Road to the southbound ramps. The NH 102 bridge over I-93 will be replaced with a new bridge built directly south of the existing bridge. The Ash Street/ Pillsbury Road Bridge will be reconstructed on-line, utilizing a temporary bridge for maintenance of traffic during construction. **(Figures 2.7-14 through 2.7-16)**

- At Exit 5, NH 28 will be widened and reconstructed on-line from Symmes Drive to Liberty Drive including the reconstruction of the Perkins Road, Vista Ridge and Symmes Drive approaches, as well as the reconstruction of a portion of both Liberty and Independence Drives. The existing diamond interchange will be reconstructed and modernized. **(Figures 2.7-17 through 2.7-18)**

In addition to the overall corridor highway improvements, three new park-and-ride lots will be constructed with bus service facilities planned at Exits 2, 3 and 5, and improved at the existing park-and-ride facility at Exit 4.

- At Exit 2, the park-and-ride lot will be located adjacent to the interchange in the SE quadrant with access via Pelham Road to South Policy Street to Raymond Avenue. **(Figure 2.7-4)**

- At Exit 3, the park-and-ride lot will be located adjacent to the relocated northbound barrel in the SE quadrant of the reconstructed interchange. Access will be from NH 111 east of the Exit 3 Interchange and from a relocated NH 111A. **(Figure 2.7-7)**

- At Exit 4, the existing parking lots will be retained and a new terminal building constructed. **(Figure 2.7-14)**

- At Exit 5, the park-and-ride lot will be located in the NW quadrant of the interchange just west of the southbound off-ramp. The park-and-ride lot access will be from NH 28 and Symmes Drive connecting to NH 28. **(Figure 2.7-18)** Along with the park-and-ride facilities at Exit 5, a bus maintenance facility will be located adjacent to the park-and-ride lot, at the end of Symmes Drive, north of the former Manchester-Lawrence railroad corridor. This maintenance facility will support the implementation of the Expanded Bus Services.

Early construction of the park-and-ride facilities at Exit 2 and Exit 5 and the implementation of additional bus services are proposed in advance of the mainline highway widening work to provide options for commuters seeking alternatives during construction. The current bus service to Boston will be expanded with service from the new park-and-ride/bus station facilities along with the existing Exit 4 park-and-ride lot, and a ride-sharing program, such as vanpooling or carpooling, in conjunction with a commuter incentive program along the corridor will be implemented, as practicable, to employment centers in northern Massachusetts.

Intelligent Transportation System technologies and Incident Management strategies are an integral part of the overall transportation improvement strategy for the I-93 corridor. The Department proposes to implement some of these measures such as variable message boards, highway advisory radio broadcasts, web site information, emergency reference markers, and coordination strategies among safety agencies before the highway widening. Additional measures will be added when the highway widening is completed.

To further expand multimodal opportunities in the corridor, NHDOT recently completed a separate Bikeway Feasibility Study to identify alternative transportation corridors for pedestrian and bicycle travel between Salem and Concord, NH. The study recommended the development of a rail trail facility located along the abandoned Manchester-Lawrence railroad corridor. The Feasibility Study recommended that the I-

93 bicycle path layout, as presented in the DEIS, not be pursued. The NHDOT is continuing to work with regional and local officials to implement the Bikeway Feasibility Study recommendations.

The Selected Four-Lane Alternative will accommodate space for a potential future rail corridor or other mass transit opportunity between the MA/NH state line northerly to the Exit 5 Interchange. The potential light rail line within the highway corridor could be a link in a future rail system providing rail service between Lawrence, MA or Woburn, MA (and ultimately Boston, MA) to the south and the Manchester Airport and/or the City of Manchester, NH to the north. In addition, the proposed layout provides provisions, such as bridge replacements and continued grade separated crossings, to facilitate, and not preclude, possible future rail service on the Manchester-Lawrence line.

In 2004, the NHDOT will embark on a Transit Investment Study in conjunction with the State of Massachusetts to consider in more detail the long-term rail and transit needs for the I-93 corridor between Manchester and Boston. The study is expected to help guide future pubic and private investment decisions involving alternative corridors and various modes of public and freight transportation. The study is expected to commence in 2004 and be completed in spring of 2006.

Construction of the proposed modifications to the I-93 corridor and the implementation of the above described transportation strategies will improve overall transportation efficiency within the 19.8-mile corridor. By modernizing the highway and increasing its capacity, the flow of traffic will be improved and congestion minimized resulting in a more efficient transportation corridor and improved safety.

The project also includes the establishment of a Community Technical Assistance Program. This proposed initiative will supplement local land use planning by making available technical planning assistance to help communities in the area influenced by this section of I-93 better deal with and manage growth and development pressures.

NHDES and NHF&GD recognize the need and importance of the project and have indicated satisfaction with the project mitigation and enhancements. USEPA has indicated they would not veto the project based on the proposed mitigation. USACOE confirmed the Selected Alternative as the Least Environmentally Damaging Practical Alternative and that the project mitigation and enhancement meet requirements of the 404(b)(1) Guidelines.

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2.7.2 Impacts of Selected Alternative

Impacts of the Selected Alternative including transportation improvements and costs are summarized in **Figure 2.7-23**. Relative to air quality, construction of the Selected Alternative will not lead to any exceedance of state or federal Carbon Monoxide (CO) standards. From a mesoscale level, the project will be in compliance with both the 1990 Clean Air Act Amendment and the New Hampshire State Implementation Plan.

From a water quality standpoint, pollutant loading will increase slightly in four streams, but be lower or show no net increase in 17 of 21 streams crossed by the Selected Alternative, because of the proposed stormwater-treatment measures. These measures include grassed swales and detention basins throughout the length of the project corridor. The Tight Shift Option at Exit 3 is expected to improve the quality of stormwater runoff eventually reaching Canobie Lake (Salem's municipal water supply). Water quality will be improved by moving the highway away from Canobie Lake and by moving the northbound on and off-ramps out of the watershed. Potential impacts to surface waters due to road salt application continues to be a regional issue and NHDOT will continue to monitor chloride levels in selected streams in cooperation with NHDES and USEPA. From a groundwater recharge standpoint, about 82 acres of stratified drift aquifer will be unavoidably covered with new, impervious roadway surface (including the Exit 5 park-and-ride lot). In addition, widening the highway will require that culverts be lengthened at many of the 23 stream crossings, resulting in some loss of aquatic habitat, including one additional perennial stream affected by the park-and-ride facility at Exit 5.

The Selected Alternative will impact an estimated 6 acre-feet of floodway and 43 acre-feet of 100-year floodplain. The largest impacts occur to the floodplains lying along Policy Brook, Porcupine Brook, Harris Brook, and Beaver Brook. Mitigation has included steepening highway embankments and utilizing retaining walls where appropriate. Additional mitigation will include providing flood storage in the form of stormwater detention basins and newly created wetlands in locations adjacent to or upstream of flood-prone areas.

Because the majority of the highway widening and other improvements will take place within the existing right-of-way, only about 10 acres of important farmland soils will be converted under the Selected Alternative. Approximately 40 percent of this conversion involves prime farmland soil, while the remainder is statewide or locally important farmland soils. About one acre of currently active farmland will be affected by the Selected Alternative, primarily at Exit 1.

The Selected Alternative will impact approximately 77[18] acres of wetlands . The majority (64 percent) of this impact occurs to forested wetland, the most common type along the highway corridor. In addition, three vernal pools, which function as essential breeding habitat for mole salamanders and wood frogs, will be impacted by the filling associated with the highway widening. The sum total of all habitat loss, i.e., both wetlands and uplands, is estimated to be about 260 acres with the Selected Alternative, which includes the three proposed park-and-ride lots. The proposed wetland mitigation package consisting of about 26 - 34 acres of wetland/floodplain creation and approximately 1000 acres of land preservation will offset this loss. Only one known location of a state-threatened or -endangered plant species, the wild lupine (*Lupinus perennis*), will be affected. Attempts will be made to relocate colonies of this species as mitigation. Although the state threatened and endangered hognose snake (*Heterodon platyrhinos*) has been reported within the vicinity of the corridor, no known locations will be affected by the project. A field study conducted within the project corridor and at the proposed mitigation sites found no evidence of the New England cottontail (*Sylvilagus transitionalis*), a candidate species for federal protection. The Selected Alternative is not expected to have any effect on this species.

The Selected Alternative will result in elevated noise levels at certain receptor locations along the project corridor. In the year 2020, 51 more receptors will experience noise levels that approach or exceed the FHWA's Noise Abatement Criteria as compared to current conditions (i.e., 316 versus 265 receptors, mostly homes). Sound walls have been proposed to mitigate these sound impacts wherever practicable from a cost and effectiveness standpoint. Visual impacts of the Selected Alternative will be largely limited to highway profile elevation changes, especially at Exit 3. The reduction of the median width and reduction of the natural vegetation buffer between the highway and adjacent development will also have some negative effect on aesthetics.

From a cultural resources standpoint, the Selected Alternative affects 23 sensitive archaeological sites; 11 of which are Native American sites and 12 are historic archaeological resources. The Selected Alternative will also affect six extant historic structures and properties, which have been determined to be eligible for the National Register of Historic Places (i.e., Kinzler House, Robert Armstrong House, George Armstrong House, Robert J. Prowse Memorial Bridge, Reed Paige Clark Homestead, and Gearty House). There will be adverse effects to the Robert Armstrong House, George Armstrong House, Robert J. Prowse Memorial Bridge, and the Gearty House.

Widening and interchange improvements associated with the Selected Alternative will require the acquisition of 21 residential and 14 business structures, including 8 residential and 3 business structures associated with the new park-and-ride lots. NHDOT conceptual relocation studies indicate that alternative housing and business sites are available for residential and business relocations. The effect on the tax bases of the acquisitions is not substantial and amounts to a loss of approximately $11.0

[18] See Appendix B for a detailed listing of wetland impacts for the Selected Alternative, which has been revised since publication of the DEIS.

million out of a total of $7.1 billion in assessed value for the five communities. This results in a total reduction of about $.20 million in local tax revenues or less than 0.1 percent for the five communities. There will be no environmental justice impacts as no minority or low-income populations are differentially affected by the project. In addition, no community facilities (e.g., schools, fire stations, town buildings, public parks, etc.) will be affected. Secondary growth impacts in the I-93 region may involve an increase in population of nearly 41,000 people and an increase in employment opportunities amounting to almost 22,000 additional jobs by the Year 2020.[19] These increases are in addition to what might be expected if the highway were not built.

An estimated 13 sites with potential hazardous materials involvement will be affected by the project. These sites will require further study, although none is expected to pose a substantial problem.

From an energy standpoint, the Selected Alternative will create a more efficient flow of traffic resulting in future fuel conservation as compared to the No Build. The widening and other improvements will require a higher expenditure of energy for various maintenance activities like plowing, sanding, roadway surface and bridge repairs, as compared to current conditions.

2.8 Project Costs

A detailed breakdown of the estimated project costs in 2002 dollars for the Three-Lane and the Four-Lane Alternatives are shown in **Figures 2.8.-1 and 2.8.-2**. The tables depict transportation infrastructure improvement costs related to I-93 mainline and interchange ramp configurations, the costs associated with reconstructing the local connecting roadways, the costs connected with bridge widening and replacement and costs associated with Intelligent Transportation System (ITS) measures to further enhance vehicle operations and incident management. The tables also identify costs related to the implementation of the additional park-and-ride facilities. Right-of-way, design and construction engineering costs as well as costs associated with mitigating the project impacts to the environment are also identified.

The costs are broken out for the various project Segments (A-F) and for the various options evaluated.

South of Exit 1, in Salem, the designs for the Build Alternatives are the same and include four lanes. North of Exit 1, the primary differences in costs when comparing the Three-Lane Alternative with the Four-Lane Alternative is essentially the cost associated with constructing an additional 12-foot travel lane in each direction along the I-93 mainline. The difference in these costs however, are actually closer than one

[19] The numbers cited in the DEIS were for New Hampshire only and were identified as such. For consistency with the rest of the document and to avoid confusion, the combined totals for Massachusetts and New Hampshire have been substituted here for the FEIS.

would expect due to a need to provide sufficient highway width during construction to safely maintain a minimum of two lanes for both northbound and southbound traffic. With the Four-Lane Alternative, traffic would be maintained on the existing two-lane highway while the highway is widened to accommodate the additional two lanes. However, to safely maintain traffic for the Three-Lane Alternative, the highway would require over-widening to a width nearly that of the Four-Lane Alternative to provide the minimum two lanes of traffic in each direction.

Each of the five interchange layouts are the same except for where and how the ramps are merged for the Three or the Four-Lane Alternative. The park-and-ride lots and bike path layouts were developed to accommodate either the Three-Lane or the Four-Lane layout, and are therefore are essentially the same cost.

The right-of-way impacts and associated costs are based on a proposed right-of-way for a Four-Lane Alternative. This allows the proposed sound walls to be constructed in a final location and allows for construction of either the Four-Lane Alternative or Three-Lane Alternative.

For the Combination Alternative which begins at the MA/NH border in Salem with four lanes extending northerly to Windham in the vicinity of the Exit 3 Interchange and then transitioning to three lanes and extending northerly to Manchester at the I-93/I-293 split, the costs can be extracted directly from the tables. A range in costs for the Combination Alternative can be determined by adding the costs from the Four-Lane Alternative, Segments A, B, C, and D, to the costs for the Three-Lane Alternative, Segments E, F. The estimated Combination Alternative Total Costs range from $392.7 to $439.7 million.

For the Three-Lane Alternative, the range for the low and the high cost is estimated to be from $381.4 to $420.3 million. For the Four-Lane Alternative, the range for the low and the high cost is estimated to be from $400.9 to $440.4 million.

The estimated cost of the Selected Alternative which includes the mainline widening and reconstruction (4 lanes in each direction), interchange reconfigurations, bridges, modifications to local roadways as well as engineering, right-of-way and environmental mitigation is $421.4 million (see **Figure 2.8-2**).

3

Affected Environment

3.1 Introduction

This chapter provides a description of the existing or baseline conditions in the study area. Current traffic and transportation conditions as well as natural, socio-economic, and cultural resources are described. It is this affected environment that potential improvements and their associated impacts of the various project alternatives will be evaluated against (see Chapter 4).

3.2 Transportation

This section summarizes the traffic data collection effort, traffic volume trends, existing operational conditions, and vehicle crash research, and identifies existing infrastructure deficiencies. The section also includes a discussion on High Occupancy Vehicle (HOV) facilities and Transportation Demand Management (TDM).

The data collection effort includes origin-destination surveys, travel time and delay surveys, vehicle occupancy counts, and vehicle classification counts.

The Traffic Volumes Section (3.2.2) and the Existing Traffic Operations Section (3.2.3) summarize the existing traffic volume trends, the development of appropriate design hour volumes, and the results of the existing traffic operations evaluation.

The infrastructure conditions and needs assessment includes a discussion of the existing highway facility layout and identifies geometric deficiencies along the corridor. This assessment also includes a description of pavement conditions and a summary of bridge conditions within the study area.

■

3.2.1 Traffic Data Collection

Because of the regional nature of the service I-93 provides, data collection efforts were concentrated both within and outside the study corridor. In addition, due to the size and scope of the study of I-93 between Manchester and Salem, New Hampshire, an extensive data collection program was required. From this information existing travel patterns,

characteristics, and the facility level of service was determined. The data collection program consisted of the following components:

- Origin – Destination Survey
- Travel Time and Delay Survey
- Vehicle Occupancy Counts
- Compilation of Traffic Volume and Vehicle Classification Counts

Details of each component are discussed briefly below. Traffic volumes and vehicle classification counts were available through the New Hampshire Department of Transportation (NHDOT).

3.2.1.1 Origin-Destination Study

In 1992, during the months of June and July, an extensive origin-destination survey was conducted of motorists traveling along I-93 and at roadway locations that parallel or feed I-93. Survey locations were set-up, where motorists were momentarily stopped and given a postcard survey questionnaire. Motorists were asked to answer the questions and return the cards by mail at no cost to the respondent.

Note that because a number of years have passed since the original survey was conducted, a more limited, but more recent, survey was conducted in October and November of 2001 for the purpose of validating the previous survey results. The recent survey, which is summarized below, did substantiate the findings of the original survey.

The recent 2001 survey consisted of the distribution of survey cards between 6:00 AM and 10:00 AM to motorists entering I-93 southbound at Exits 1 through 5. In addition, survey cards were distributed to southbound motorists at the Hooksett Toll Plaza. A total of 16,108 survey questionnaires were distributed with an overall response rate of 32 percent (5,170 cards). The highest response rate was attained from motorists entering the highway at Exit 1, while the lowest response rate was recorded at Exit 5.

Of the total respondents, which includes those receiving cards at the Hooksett Tolls, approximately 50 percent were ending their trip in Massachusetts. However when considering only the respondents entering the highway at Exits 1 through 5, approximately 80 percent were destined to Massachusetts. The highest number of respondents began their morning trip in Salem (462), followed by Derry (405), Londonderry (352), Windham (217), and Manchester (139).

Questions pertaining to other trip characteristics such as, trip purpose, vehicle occupancy, potential mass transit ridership, and travel frequency were posed. The responses are briefly described below.

Trip Purpose

During peak travel hours, I-93 is primarily used as a commuting facility between home and work. At the time they received the survey card, a total of 92 percent of the respondents began their respective trips from home and a total of 84 percent were traveling to work. Less than 1 percent of the total respondents stated that they were traveling to a mass transit terminus: carpool lot, bus stop, or train station.

Vehicle Occupancy

Eighty-two percent of respondents indicated that they made their respective trips alone, while 11 percent of the trips included one passenger, and 7 percent of the vehicles carried more than one passenger. To validate the results on this question, vehicle occupancy counts were conducted along I-93 southbound south of Exit 1 on Tuesday, April 23, 2002 and on Tuesday, May 7, 2002 from 6:00 AM to 10:00 AM. The occupancy counts revealed a substantially higher percentage of single occupancy vehicles (92 percent) with only 8 percent of vehicles with more than one occupant. One reason for the discrepancy is that the survey card return rate may be higher in vehicles with multiple occupants because a passenger is more likely to fill out the survey card during the commute while the motorists who is traveling alone is more likely to put the card aside while driving. Therefore, the actual percentage of single occupancy vehicles is likely closer to the 92 percent that was observed than the 82 percent that was obtained through the survey.

Carpool/Vanpool Use

Drivers were asked whether or not the trip they were taking at the time that they received the card was part of a carpool or vanpool; 97 percent responded in the negative. Of those whose trip was part of a carpool or vanpool, 75 percent were part of a daily carpool/vanpool, while 25 percent used this form of travel only occasionally.

Preferred Mass Transit

Drivers were given a list of potential mass transit options and asked which they would likely use, if they were made available to them: 61 percent responded that they would not use mass transit; 29 percent would ride a train; 15 percent would likely use a bus; and 10 percent would arrange travel on highway lanes developed for high occupancy vehicles (HOV).

Frequency of Travel

A total of 73 percent of the drivers responded that the trip they were taking at the time they received the questionnaire occurred five or more times per week. In contrast, only 9 percent of the respondents replied that the trip occurred less than one time per week, and 8 percent replied that the trip was taken one to two times per week.

3.2.1.2 Travel Time and Delay Study

A travel time and delay study was conducted along I-93 from the I-293 split in Manchester to the Massachusetts state line in April 2000. The travel time runs were conducted in the southbound direction during the weekday morning peak period and in the northbound direction during the weekday evening peak period. Checkpoints consisting of the interchanges were established along the corridor to note travel times. The prevailing travel speeds between checkpoints were recorded.

The results of the travel time and delay study confirm that under existing conditions, motorists experience substantial delay along the I-93 corridor during the weekday morning and evening peak commuter periods.

During the morning peak period in the southbound direction, the prevailing speeds were recorded as follows:

Segment	2000 AM Peak Southbound Prevailing Speed
I-293 to Exit 5	60-70 mph
Exit 5 to Exit 4	55-65 mph
Exit 4 to Exit 3	50-65 mph
Exit 3 to Exit 2	40-50 mph
Exit 2 to Exit 1	30-40 mph
Exit 1 to State line	55-65 mph

During the morning peak period in the southbound direction, motorists generally travel under free flow conditions from I-293 to Exit 5 with prevailing speeds ranging from 60 mph to 70 mph. Travel speeds slow (50 mph – 65 mph) with more noticeable congestion between Exit 5 and Exit 3. Between Exit 3 and Exit 2 more substantial congestion is experienced with speeds reduced to 40 mph to 50 mph. The most substantial congestion in the southbound direction is experienced between Exit 2 and Exit 1 with speeds reduced to 30 mph to 40 mph. The wider cross section south of Exit 1 allows speeds to increase to 55 mph to 65 mph.

During the evening peak period in the northbound direction, the recent travel time runs revealed the following average travel speeds:

Segment	2000 PM Peak Northbound Prevailing Speed
State line to Exit 1	15-35 mph
Exit 1 to Exit 2	20-40 mph
Exit 2 to Exit 3	35-60 mph
Exit 3 to Exit 4	55-65 mph
Exit 4 to Exit 5	60-70 mph
Exit 5 to I-293	60-70 mph

During the evening peak period in the northbound direction, motorists experience substantial delay south of Exit 1 with travel speeds recorded at 15 mph to 35 mph. Traffic flow along this segment is routinely "bumper to bumper." Substantial congestion continues to be experienced between Exit 1 and Exit 2 with only modest increases in travel speeds ranging from 20 mph to 40 mph. Somewhat higher speeds (35 mph to 60 mph) are obtained between Exit 2 and Exit 3. The level of congestion begins to diminish north of Exit 3 where speeds of 55 mph to 65 mph were recorded between Exit 3 and Exit 4. North of Exit 4, motorists can generally travel at free flow conditions with speeds ranging from 60 mph to 70 mph.

3.2.1.3 Vehicle Classification

The classification of vehicles by type (i.e. passenger car, single-unit truck, tractor-trailer, bus) is an important part of the data collection program, specifically for use in air quality and noise studies along the study corridor. Vehicle classification counts have been performed periodically at various locations along I-93 within the study area as required to address specific project needs. Counts performed in the late 1980's/early 1990's indicated that truck traffic made up approximately 7.5 percent of the total traffic volume. Classification counts performed in 1997 between Exits 3 and 4 indicated that truck volumes were running about 10 percent of total traffic. Counts in 1999 between Exits 1 and 2 showed the truck percentage to be 9.5 percent. In summary, the data indicates that while percentage of truck traffic is increasing to some degree, I-93 remains largely a commuting facility with passenger vehicles making up a vast majority of the vehicles along the corridor.

■

3.2.2 Traffic Volumes

The purpose of this section is to establish and evaluate the existing traffic conditions along the study corridor. This section includes a discussion on traffic volume trends, the development of an appropriate design hour volume condition, and the results of the existing conditions traffic operations evaluation.

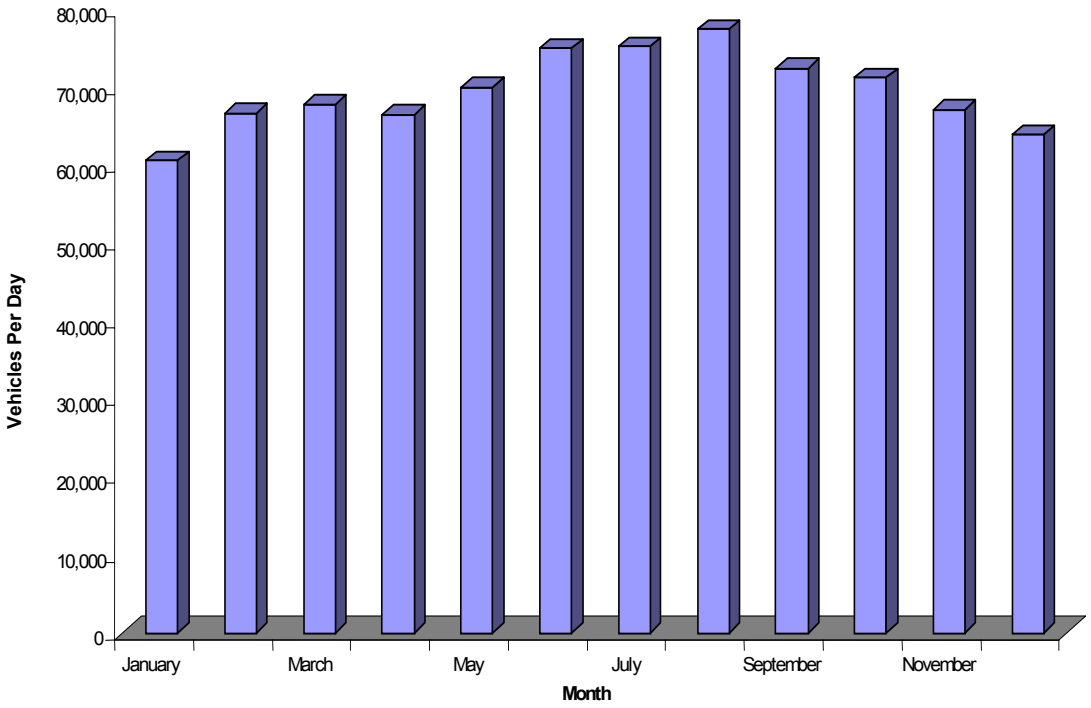
Traffic Volume Trends

The NHDOT maintains two (2) automatic traffic volume recorder stations (24-hour operation) along I-93 northbound and southbound within the study area – Station 399001/399002 in Salem, just south of Rockingham Park Boulevard, and Station 489003/489004 in Windham, north of Exit 3. To supplement these counts, the NHDOT conducted 1997 weekday morning and evening peak period traffic counts at each interchange (Exit 1 through Exit 5) area. These peak hour volumes were seasonally adjusted to reflect an annualized average weekday condition based on a review of monthly traffic volume variations at the Salem and Windham control counting stations. Peak hour traffic volumes are approximately nine percent of daily volumes, and reflect

the commuter orientation of the corridor where approximately 60 percent of the traffic flow is southbound in the morning peak hour, and northbound in the evening peak hour.

Examination of the monthly variation in average daily traffic (ADT) along I-93 shows August with an ADT of 77,500 vehicles per day (vpd) as the peak month. Despite the influence of ski activity during the winter months, the volume of traffic on a daily basis is somewhat higher during the summer recreational months of June, July, August and September. October volumes (71,000 vpd) reflect foliage season. The monthly variations are shown graphically in **Exhibit 3.2-1**.

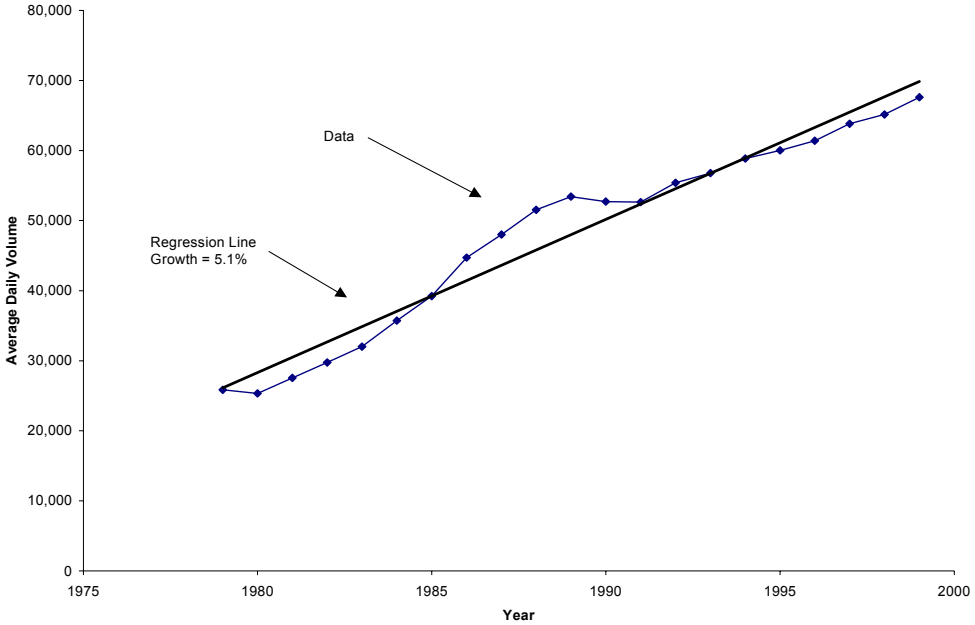
Exhibit 3.2-1
Monthly Variations, I-93 at Fordway Extension Bridge in Derry
Average Daily Traffic (2000)



In addition to reviewing seasonal trends, historical traffic growth trends were also examined. The NHDOT permanent traffic recorder count station located along the northbound and southbound barrels between Exits 3 and 4 have provided historical traffic volume data for the past 20 years. The growth in ADT (total northbound and southbound) is depicted in **Exhibit 3.2-2**. The ADT over the 20-year period revealed an average annual growth rate of 5.1 percent. The most substantial growth occurred during the 1980's with the rate of increase slowing during the 1990's. In fact the rate of growth has been steadily declining since the mid-1980's with rates decreasing from 9.9 percent

(1980 to 1985), to 5.4 percent (1985 to 1990), to 2.6 percent (1990 to 1995), and to 1.9 percent (1995 to 2000).

Exhibit 3.2-2
Windham (Exits 3-4) Derry Town Line —Average Annual Traffic Growth

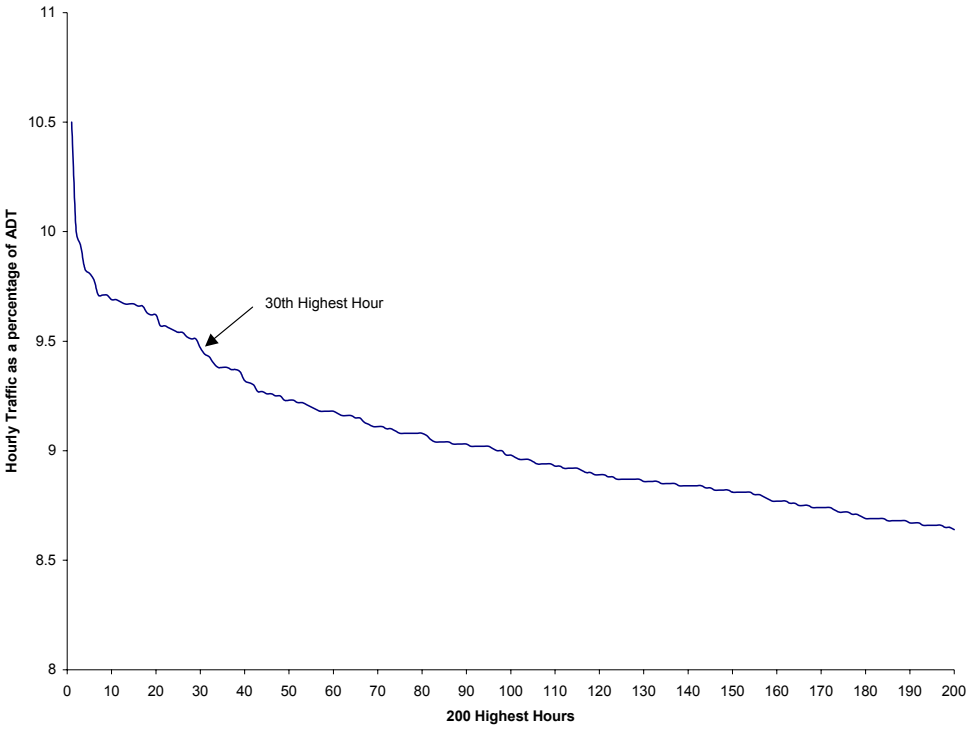


The general unit of measure used to quantify roadway usage is the average daily traffic (ADT), which is defined as the total volume of traffic during a given period of time divided by the number of days in that time period. A more specific unit of measure is known as the average annual daily traffic volume (AADT), which is determined by dividing the total yearly volume by the number of days in the year. Although an actual AADT can only be established at a continuous count station, AADTs can be estimated along segments of roadways by applying adjustment factors developed from data collected at continuous count stations to specific daily or hourly counts.

While the AADTs are an important measure, it is the hourly volume condition that is primarily used to evaluate and design roadway facilities. However, because hourly traffic volumes can vary substantially over the course of a day and throughout the year, it is necessary to select an appropriate design hourly volume condition. A design based on the (maximum) peak hour traffic of the year is not an appropriate design hour volume condition. Designs based on such extreme conditions would be a poor investment of public funds given the size of the facility that would be required. Similarly, the average hourly traffic volume condition would result in an inadequate design as it would be exceeded half of the time. In accordance with industry practice, the hourly traffic volume used for the purpose of design should not be exceeded very often or by very much, while on the other hand, it should not be so high that the volume of traffic would rarely be high enough to make full use of the facility.

As recommended in *A Policy on Geometric Design of Highways and Streets,*[20] the hourly traffic volume that should generally be used for the design of a highway facility is the 30th highest hour volume of the year. Given the economic considerations involved in the planning and design of roadway facilities, this design criteria is selected since the 30th highest hourly volume generally reflects a "point of diminishing return" in that a substantial increase in design requirements would accommodate only very few periods of higher traffic volumes. This condition is reflected in the curve, as shown in **Exhibit 3.2-3**, which tends to steepen quickly to the left of the 30th highest hour indicating much higher volumes for the inclusion of only a few more of the higher hourly volumes, while the curve flattens to the right indicating many hours in which the volume is not much lower than the 30th highest hour.

Exhibit 3.2-3
Peak Hour to ADT Relationship—I-93 at Fordway Bridge in Derry (1997)



Based on the data provided at the NHDOT permanent count station, the 30th highest hour volume is approximately 9.4 percent of the ADT. The Directional Design Hour Volume (DDHV) split shows approximately 60 percent of the total hourly traffic traveling in the peak direction.

[20] American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets, Washington, D.C., 2001.

As shown in Table 3.2-1, the 1997 ADT along the corridor ranges from a low of approximately 61,800 vehicles per day (vpd) between Exits 3 and 4 to a high of approximately 104,400 vpd south of Exit 1. The most recent traffic count data (2003) for the area south of Exit 1 shows the traffic volumes have increased from 104,400 in 1997 to 114,000 vpd. The 1997 DHV ranges from approximately 5,800 vehicles per hour (vph) to 9,800 vph. Similarly, the DDHV ranges from approximately 3,500 vph to approximately 5,900 vph.

Table 3.2-1
1997 Base Year Traffic Volumes[4]

Segment	ADT[1]	DHV[2]	DDHV[3]
MA State Line to Exit 1	**104,400**	9,800	5,900
Between Exits 1 and 2	**81,100**	7,600	4,600
Between Exits 2 and 3	**74,900**	7,000	4,200
Between Exits 3 and 4	**61,800**	5,800	3,500
Between Exits 4 and 5	**64,900**	6,100	3,700
North of Exit 5	**69,300**	6,500	3,900

1 ADT – Average Daily Traffic
2 DHV – Design Hour Volume (9.4% of ADT)
3 DDHV – Directional Design Hour Volume (60% of DHV)
4 All Volumes are based on I-93 Subarea Traffic Model (see Traffic Forecasting Section)

The 1997 weekday morning and evening peak hour traffic volumes at each of the study corridor intersections are presented in **Figures 3-16 and-3-17**.

■

3.2.3 Existing Traffic Operations

The volume of traffic along the I-93 corridor indicates the importance of the corridor to the regional transportation system, but does not necessarily give an indication of the quality of traffic flow. To assess the quality of traffic flow along the corridor and other study area roadways, capacity analyses were conducted to determine how well the I-93 corridor serves the traffic demands placed upon it. The traffic performance measures and the evaluation criteria used in the operational analyses are based on the methodology presented in the 2000 Highway Capacity Manual.[21]

A primary result of capacity analysis is the assignment of level of service, which is a qualitative measure describing operational conditions within a traffic stream and their perception by a motorist or passenger. Level of service generally describes these conditions in terms of such factors as speed and travel time, density or freedom to maneuver, traffic interruptions, comfort and convenience, and safety and, in so doing,

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[21] 2000 Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington, D.C.

provides an index to quality of traffic flow. Six levels of service (LOS) are defined[22] ranging in letter designation from LOS A to LOS F, with LOS A representing the best operating condition and LOS F representing the worst. LOS C describes a stable flow condition and is considered desirable for peak or design hour traffic flow. LOS D is generally considered acceptable where the cost and impacts of making improvements to provide LOS C are deemed unjustifiable. Level of Service E is capacity.

The results of the freeway segment analyses, as summarized in Table 3.2-2, show poor operating conditions (LOS E) along I-93 from Exit 1 to Exit 3. Field observations reveal that the traffic congestion associated with the capacity conditions in the northbound direction during the PM peak hour often reverberates south of Exit 1 and into Massachusetts.

When considering the operating conditions of a highway, it is important to consider the magnitude of congestion in terms of the time frame over which a poor level of service occurs. The level of service ratings in Table 3.2-2 are based on a one-hour period. The peak period for I-93 actually extends well beyond a single hour. This phenomenon, which is known as "peak hour spreading," occurs when segments of a corridor are so congested that the poor level of service extends into the hour before and the hour following the peak hour. In doing so, the actual operating conditions of the highway are somewhat worse (and the number of motorists affected greater) than what is indicated by evaluating a single one-hour period.

Table 3.2-2
1997 Existing Conditions - Freeway Segment Analysis Summary

Segment	DHV[1]	DDHV[2]	# Lanes	LOS[3]
MA State line to Exit 1	9,800	5,900	3	E
Exit 1 to Exit 2	7,600	4,600	2	E
Exit 2 to Exit 3	7,000	4,200	2	E
Exit 3 to Exit 4	5,800	3,500	2	D
Exit 4 to Exit 5	6,100	3,700	2	D
North of Exit 5	6,500	3,900	2	D

1 DHV=Design Hour Volume.
2 DDHV=Directional Design Hour Volume.
3 LOS=Level of Service.

The poor level of service for 1997 peak hour traffic flow and the congestion associated with the main line capacity between Exits 1 and 3 also extend to interchange traffic operations, as summarized in Table 3.2-3. LOS F conditions exist during the morning peak hour at the Exit 1 southbound off- and on-ramps, at the Exit 2 southbound off- and on-ramps (weaving movement), and at the Exit 3 southbound on-ramp. Capacity (LOS E) conditions exist at the Exit 3 southbound off-ramp. During the evening peak hour,

[22] ibid.

interchange capacity is exceeded (LOS F) at the Exit 1 northbound on-ramp, at the Exit 2 northbound on- and off-ramps, and at the Exit 3 northbound off-ramp.

Table 3.2-3
Interchange Ramp Junction Analysis Summary — 1997 Existing Conditions

Interchange Movement	Level of Service	
	AM Peak Hour	PM Peak Hour
Exit 1		
NB off-ramp	A	B
NB on-ramp	B	F
SB off-ramp	F	D
SB on-ramp	F	D
Exit 2		
NB off-ramp	B	F
NB on-ramp	B	F
SB off-ramp (weave)	F	D
Exit 3		
NB off-ramp	B	F
NB on-ramp	B	D
SB off-ramp	E	C
SB on-ramp	F	C
Exit 4		
NB off-ramp	B	D
NB on-ramp	B	C
SB off-ramp	D	C
SB on-ramp (from E)	C	B
SB on-ramp (from W)	D	B
Exit 5		
NB off-ramp	B	C
NB on-ramp	C	C
SB off-ramp	C	C
SB on-ramp	C	C

■

3.2.4 Crash Statistics

Crash statistics compiled by the New Hampshire Department of Transportation are based on information provided by the New Hampshire Department of Safety (NHDOS). These data are only as accurate as what is reported to the NHDOT. Statistics for the eight-year period of January 1995 through December 2002 were reviewed. The crash data for the study area, which extends

from the Massachusetts state line to I-293, revealed a total of 2,427 crashes during the eight-year period. A summary of the crash data is presented in Table 3.2-4.

Table 3.2-4
Crash Summary (January 1995 – December 2002)

Location	Property Damage Only	Personal Injury	Fatal Crash	Total
From MA state line to Exit 1	158	74	2	234
At Exit 1	26	11	0	37
From Exit 1 to Exit 2	170	74	3	247
At Exit 2	28	6	0	34
From Exit 2 to Exit 3	191	91	2	284
At Exit 3	31	6	0	37
From Exit 3 to Exit 4	491	180	4	675
At Exist 4	31	10	0	41
From Exit 4 to Exit 5	215	88	3	306
At Exit 5	37	11	1	49
From Exit 5 to I-293	257	136	4	397
At I-293	28	8	0	36
Unknown	46	4	0	50
Total	1709	699	19	2427

Year		Month	
1995	253	January	292
1996	236	February	191
1997	203	March	259
1998	292	April	164
1999	243	May	212
2000	463[1]	June	198
2001	386	July	184
2002	351	August	197
Total	2427	September	172
		October	198
Surface Condition		November	170
Dry	1741	December	190
Wet	289	Total	2427
Snow/Ice	371		
Debris	5		
Unknown/Other	21		
Total	2427		

1 Beginning in the year 2000, a more detailed accident record-keeping system was initiated.

Although caution should be applied when attempting to relate crash trends to potential causation, the following trends have been identified.

The segment of I-93 between Exits 3 and 4 recorded the highest number of crashes with 675 crashes (28 percent). Three hundred and ninety-seven crashes (16 percent) were recorded between Exit 5 and I-293. The segments between Exits 4 and 5, and between Exits 2 and 3 recorded 306 crashes (13 percent) and 284 crashes (12 percent), respectively.

The segments between Exit 1 and Exit 2, and between the MA state line and Exit 1 recorded the fewest crashes with 247 (10 percent) and 234 (10 percent), respectively. The number of crashes that occurred at each of the interchanges range from a low of 34 at Exit 2 to a high of 49 at Exit 5.

The roadway surface condition was recorded as dry for 1,741 crashes (72 percent), snow or ice for 371 crashes (15 percent), and wet for 289 crashes (12 percent). Five crashes were related to debris in the roadway. The road condition for the remaining 21 crashes are unknown.

Of the total 2,427 crashes, 1,709 (70 percent) were limited to property damage only, while 699 crashes (29 percent) resulted in personal injury. Nineteen crashes (1 percent) resulted in a fatality. Of note, 15 of the 19 fatal crashes involved only a single vehicle.

The number of crashes that occurred between 1995 and 1997 revealed a steady decline with the number of crashes each year recorded at 253, 236 and 203, respectively. However, the trend was broken in 1998 when 292 crashes were recorded. The number of crashes again declined in 1999 with 243 crashes reported. However, since 1999 the number of reported crashes has been much higher. The 3-year period of 2000, 2001, and 2002 recorded 463, 386, and 351 crashes, respectively. This may be in part due to an ongoing effort by NHDOS and NHDOT to improve record-keeping and accuracy relative to crash data.

The month of January recorded the highest number of crashes with 292. The next four highest months were March, May, June and October with 259, 212, 198, and 198, respectively.

■

3.2.5 Geometric Deficiencies

This section summarizes the geometric concerns and deficiencies that currently exist along the I-93 segment under study. These were identified by comparing the existing horizontal and vertical geometry with parameters listed in *A Policy on Geometric Design of Highways and Streets*[23] *(AASHTO)* and *The Policy for Interstate Highways (AASHTO)* for the same type of highway facility and based on current NHDOT standards. AASHTO provides desirable and minimum/maximum design parameters for each design element, which allow for some flexibility in design. The desirable value provides a somewhat higher level of safety, efficiency and comfort, relative to the minimum/maximum design parameters. Both must be balanced with acceptable impacts and costs. Desirable values are preferred particularly for Interstate-type facilities, where the public expectations are generally higher.

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[23] American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets, Washington, D.C., 2001.

I-93 is a major link in the Interstate System and functions as a principal arterial Interstate highway, also referred to as a freeway. Access to this facility within the study area, is only available from the five interchanges spaced along the corridor. The connecting roadways at each interchange function as minor arterials, which serve as links between the municipalities in the region. Four types of facilities were identified for establishing design criteria for comparison and evaluation. These facilities and some of the corresponding design criteria are shown in Table 3.2-5.

Table 3.2-5
Road Design Criteria

	Roadway Classifications			
	Local Road	**Arterials**	**Ramps**	**Freeways**
Design Speed	30-40 mph	40-50 mph	50 mph (at nose) 30-40 mph (on ramp)	70 mph
Maximum Grade	8%	5% desirable	4% desirable	4% desirable
Minimum Grade	0.5%	0.5%	0.5%	0.5%
Superelevation	4% maximum	8% maximum 4% max. @ intersections	6% maximum	8% maximum
Horizontal and Vertical Curves	AASHTO minimum or better	AASHTO minimum or better	AASHTO minimum or better	AASHTO minimum or better
Lane Width	11 ft. minimum 12 ft. desirable	12 ft.	16 ft.	12 ft.
Shoulders	4 ft. minimum	4 ft. minimum	Varies	10 ft. to 12 ft.
Access Control	None	Control desirable	Full Control required	Full Control required
Intersection/ Interchange Spacing	600 ft. desirable	0.25 mile desirable		1.0 mile urban 2.0 mile rural
		Structures Criteria		
		Minimum Vertical Clearance: 16 ft. – 6 in. over major roadways 14 ft. – 6 in. over minor roadways 22 ft. – 6 in. over railroads Minimum grade 1% (desirable)		

The following is a summary of the roadway elements along the I-93 corridor where the existing roadway geometry does not meet current recommended design criteria based on current AASHTO and NHDOT standards. Where possible, improvements would be made to upgrade the existing facility and provide for current desirable design standards. In areas where geometric improvements would create unacceptable environmental or socio-economic impacts or involve unreasonable costs, those roadway elements would likely be improved to the minimum standards allowable.

I-93 Mainline

South of Exit 1 - the Rest Area/Welcome Center has a less than desirable length for the deceleration lane and on and off-ramp geometry that will only accommodate a 30 mph design speed.

Between Exits 1 and 2 - there are no geometric deficiencies along the I-93 mainline.

Between Exits 2 and 3 - the southbound barrel has a down-grade of 4.5 percent between Brookdale Road and Pelham Road.

Between Exits 3 and 4 - both the southbound and northbound barrels have grades as steep as 5 percent.

Between Exits 4 and 5 - there are no geometric deficiencies along the I-93 mainline.

Between Exit 5 and the I-93/I-293 split in Manchester – flat grades of less than the minimum 0.5 percent exist along the I-93 mainline, both northbound and southbound, near Bodwell Road. In addition, the tapers for creating the split between I-93 and I-293 are short and abrupt, but are being addressed as part of the project to rehabilitate the bridges carrying I-93 over Bodwell Road and Cohas Brook.

Interchanges

Exit 1 consists of a three-legged, trumpet type interchange.

- Southbound On-Ramp
  - Two on-ramp lanes converge with two I-93 travel lanes and taper to three through lanes at a minimum rate of 50:1 (70:1 desirable for multi-lane merge condition).

- Southbound Off-Ramp
  - 300 feet parallel deceleration length (less than minimum length of 550 feet)
  - Southbound Off-Ramp radii at 180 feet (<30 mph design; minimum radii is 230 feet)

- Northbound On-Ramp
  - 30:1 Acceleration Taper (50:1 minimum)

- Northbound Off-Ramp
  - Short weave (2,000 feet) between Rest Area On-Ramp and Exit 1 Off-Ramp

Exit 2 is a partial cloverleaf/partial diamond interchange.

- The southbound direction poses a problem for traffic trying to exit the highway while traffic is trying to enter the highway over such a short weave distance. This

short weaving section (675 feet) is less than the minimum length required by NHDOT design standards (1,000 feet) for good operation with projected traffic volumes.

- Close spacing between the southbound ramps/NH 97 intersection and the Keewaydin Drive/NH 97 intersection creates poor traffic operations between signals.

- Northbound On-Ramp
  - 25:1 acceleration taper (50:1 minimum)

- Steep up-grade from Northbound On-Ramp (4 percent) transitioning into grade of I-93 Northbound (3 percent) creates difficulty for trucks to merge into I-93 Northbound traffic.

Exit 3 is a half-cloverleaf interchange. The Southbound Off and Northbound On ramps are loop ramps.

- Southbound Off-Ramp
  - Southbound Off-Ramp grade of 5 percent (the down-grade coupled with the relatively sharp horizontal curvature further complicates the geometry of this ramp).

- Southbound On-Ramp merge with the I-93 mainline is a problem due to the short acceleration length of 1,100 feet, which is less than the desirable length of 1,400 feet (or the AASHTO minimum length of 1,350 feet).

- Northbound On-Ramp
  - 45:1 acceleration taper with a 4-foot shoulder (minimum taper is 50:1 with a 10-foot shoulder).
  - Steep grade from Northbound On-Ramp (4 percent) transitioning into grade of I-93 Northbound (3 percent) creates difficulty for trucks to accelerate and merge into I-93 Northbound traffic.

- NH 111
  - Steep grade of 4.9 percent along NH 111 between northbound and southbound barrels (greater than 4 percent grade for arterial highway where traffic may be stopped on approach to an intersection is undesirable).
  - Proximity of signals along NH 111 at the northbound ramps and NH 111A intersections.

Exit 4 is a full diamond interchange with a free flow loop ramp that connects NH 102 Westbound to I-93 Southbound.

- Northbound On-Ramp
  - Acceleration lane has a 4-foot shoulder (standard is 10 feet at nose of on-ramp).

- Southbound Off-Ramp
  - Steep grade of 6 percent exceeds desirable maximum of 4 percent.
  - Sag vertical curve at nose has a 35 mph design speed (50 mph desirable).

- NH 102
  - Steep grade of 6 percent (greater than 4 percent grade for arterial highway where traffic may be stopped on approach to an intersection is undesirable).
  - Northbound off-ramp traffic queue on occasion extends the length of the off-ramp and on into the Northbound mainline.

Exit 5 is a full diamond interchange.

- All ramps are relatively short, resulting in traffic queues extending onto the I-93 mainline.

- Southbound On-Ramp
  - 35:1 acceleration taper with a 4-foot shoulder (minimum is 50:1 taper with a 10-foot shoulder).

- Southbound Off-Ramp
  - 250-foot long parallel deceleration length (less than 340 feet minimum).

- Northbound Off-Ramp
  - 250-foot long parallel deceleration length (less than 340 feet minimum).

- Northbound On-Ramp
  - 45:1 acceleration taper with a 4 foot shoulder (minimum is 50:1 taper with a 10-foot shoulder).
  - Vertical Curve at the nose has a 35 mph design speed (50 mph desirable).

- Short vehicle storage lengths along NH 28 between the ramp intersections.

■

3.2.6 Infrastructure Deficiencies

The existing highway was originally built in the 1960's and since that time, much of the facility has not undergone any major upgrades within the study area. Since 1990 there have been two capacity improvements along this segment of I-93. These involved widening in the northbound direction south of Exit 1 to accommodate traffic for the Mall at Rockingham Park and the reconstruction of the Exit 4 Interchange. The Rest Area just south of Exit 1 was also reconstructed in 1993, and the weigh stations just north of Exit 3 were reconstructed and expanded in 2000.

In addition to the existing geometric deficiencies identified above, a number of infrastructure deficiencies have also been identified.

Roadway

Some of the existing roadway infrastructure deficiencies, (specifically, outdated cable guard rail, deteriorating drainage systems and pipes, and deteriorating pavement) are a direct result of the age of the facility. The NHDOT has recently replaced the outdated cable guard rail system as part of a safety upgrade along this segment of I-93. The existing pavement surface requires rehabilitation and it is expected that subsurface analysis will indicate that roadway base materials will require rehabilitation over some sections of the corridor.

Bridges

There are 43 bridges on I-93 or over I-93, within the study limits. Within the past ten years, five of these bridges have been replaced, five have been rehabilitated and widened (for traffic control purposes during construction), and another four are currently under construction for rehabilitation and widening. The most recent bridge construction projects have been completed with the future widening in mind, to hopefully minimize the additional construction needed as part of the widening resulting from this study.

Eighteen of the 43 bridges are considered to be in "red list" condition (indicating the need for replacement or substantial rehabilitation). Thirteen have been identified as structurally deficient. In addition, 10 bridges do not meet NHDOT minimum vertical clearance criteria.

■

3.2.7 High Occupancy Vehicle Facilities

Currently, there are no high occupancy vehicle (HOV) lanes in New Hampshire on any facilities and none within the 18-mile segment of I-93 under study. There are two park-and-ride lots that serve carpools/vanpools and commuter bus operations. These are described in the Transportation Demand Management section. Massachusetts also has no HOV lanes on I-93 until just before the City of Boston. The Merrimack Valley Planning Council recently completed a corridor traffic study for I-93 through Methuen and Andover, Massachusetts that included a recommendation that an HOV facility north of I-495 would not be an appropriate investment.

With respect to the southbound HOV lane located on I-93 as it approaches Boston, a study done in 1994 by the Massachusetts Highway Department to consider extending the HOV lane north from the Charles River Crossing to the I-93/I-95/ MA 128 Interchange concluded that the project would attract too many additional HOVs. The HOV lane is currently operating near capacity and encouraging more HOVs would be counterproductive. The study underscored the sensitive balance required to make HOV lanes effective and practicable.

■

3.2.8 Transportation Demand Management

Transportation Demand Management (TDM) encompasses a variety of strategies that are designed to change personal travel behavior to reduce the demand for automobile use and the need for highway capacity expansion. This is accomplished through measures that reduce the number or length of trips or that move trips out of times of peak roadway congestion. TDM measures include conventional transportation services such as bus service, rail service, and providing park-and-ride lots, as well as lesser known strategies, such as work hour management, parking restrictions, and congestion pricing.

TDM programs are frequently targeted at work trips because commuters account for the majority of peak-hour travel (generally the periods of greatest roadway congestion) and because work trip patterns are generally consistent day-to-day. TDM programs that currently exist in the I-93 corridor are promoted at least in part through the NHDOT, the Rockingham Planning Commission and the Manchester Airport's Transportation Management Association (TMA). In addition, several TMAs operating in Massachusetts provide TDM programs that serve residents of New Hampshire while reducing traffic along I-93 in both New Hampshire and Massachusetts.

3.2.8.1 Park-and-Ride Lots

To support those who travel by carpool, vanpool or bus, the NHDOT officially recognizes a number of park-and-ride lots (not all are owned and maintained by the NHDOT) (see Table 3.2-6). A number of these serve drivers who use the I-93 corridor between Manchester and the New Hampshire/Massachusetts state line.

Existing Park-and-Ride Lots

The park-and-ride lots that serve users of I-93 are listed in Table 3.2-6. All are along I-93, either in the study area or to the north, or along I-89. Only the lots in Concord and Londonderry located along I-93 are served by bus. (There is a bus station and stop in downtown Manchester as well) They are the two largest lots with 744 spaces. They are also the most heavily utilized.

Proposed Park-and-Ride Lots

The park-and-ride lot in Windham was upgraded in 1998 to further encourage travelers to use the facility. The lot is located approximately 0.8 miles west of I-93 on Wall Street just off NH 111 with access via the unsignalized intersection of NH 111 and Wall Street. It was previously served by bus transit to Boston; however, this service was curtailed due to the lack of customers and the delay buses experienced accessing the lot.

The NH 111, Windham-Salem Final Environmental Impact Study (FEIS) recommended that consideration should be given to developing a new park-and-ride facility in North

Salem off NH 111 that would provide parking for carpoolers and possibly bus transit service from the North Salem/Windham area to points south. The property was purchased as part of the NH 111 Windham-Salem project, but was not proposed to be constructed until sometime in the future when use of the facility seems more assured.

Table 3.2-6
New Hampshire Park-and-Ride Lots[24]

Town	Location on	Number of Spaces	Occupancy Counts (8/98)	Occupancy Counts (10/99)	Services
I-89 Corridor					
New London	Exit 12, NH 103A	45	19	13	L, S, T
Warner	Exit 9, NH 103	20	10	11	L, T
Concord	Exit 2, NH 13 (Clinton Street)	100	31	48	P, L
I-93 Corridor					
New Hampton	Exit 23 East, NH 104	15	7	10	
Tilton	Exit 20, US 3 East	63	5	27	L,T
Boscawen	Exit 17, US 4	27	22	24	L
Concord*	Exit 14, Stickney Avenue	273	268	196	P, L, S, T*
Bow	Jct. of I-89 and I-93, NH 3A	60	38	60	P, L
Hooksett	Exit 11, Hackett Hill Road	45	23	8	L
Londonderry*	Exit 4, NH 102	471	389	406	P, L, S, T*
Windham	Exit 3, NH 111	150	46	67	L,S
Total		1,269	858	870	

P= Phone; L = Lighting; S = Shelter; T = Bus Transit;
T* These lots are served by Concord Trailways, which provides commuter transit service in the corridor.

The Salem-Plaistow-Windham MPO submitted a CMAQ proposal in 1998 for a lot that would accommodate ride-sharing and intercity bus service, and would be located off Rockingham Park Boulevard near Exit 1 in Salem. Plans include 460 parking spaces and a bus station with rest rooms, phones, lighting, bike racks, trash receptacles, landscaping, and signage on I-93. Acquisition of the site was accomplished by the NHDOT, and preliminary designs were developed. Permitting issues involving prime wetlands put the project on hold at least until the layout for I-93 is resolved.

Outside of New Hampshire, a new park-and-ride lot was opened in Methuen, Massachusetts in spring 2001. Located off I-93 on Pelham Street (Exit 47), the lot contains approximately 188 parking spaces for commuters who carpool/vanpool or use

[24] Occupancy counts for Londonderry and Windham were provided by the Rockingham Planning Commission. All other counts are from NHDOT, and most were completed in August of 1998. NHDOT usually does regular counts in October and finds that those completed in August tend to be lower, due to summer vacations. The count for the Bow lot in July 1999 was a random count.

commuter bus service to Boston. Amenities include a shelter, bike racks, wooden benches, trash receptacle, lighting, landscaping and signage on I-93. The bus provider relates that use of the lot and bus ridership is much less than expected.

As a temporary measure, discussions have been underway between Cisco Corporation, the Town of Salem, the Rockingham Planning Commission (RPC), the NHDOT and Trombley Bus Company of providing bus service out of an unused portion of the Cisco parking lot off Exit 2. Initial optimism that bus service would be forthcoming, has receded in light of the bus provider's low ridership from the recently opened Methuen lot previously discussed.

3.2.8.2 Ride-Matching

The NHDOT operates a Statewide Ride-Share Program through its Bureau of Rail and Transit. The program is approximately six years old and is working towards building a substantial database. There are currently over 550 people registered for ride-matching. This number continues to grow thanks in large part to the Ride-share Program's new website, www.nhrideshare.com, which allows registration forms to be filled out and submitted on line.

The NHDOT's Ride-Share Coordinator also promotes ride-sharing through individual employers by sponsoring transportation events, providing marketing materials, and encouraging employers to adopt TDM strategies, such as guaranteed ride-home programs, parking management, flex-time, and telecommuting. In this process, the State mainly targets rural areas, and depends on the Regional Planning Commissions to work with employers in the urbanized areas.

The RPC also promotes ride-matching through the State's Ride-Share Program. Four years ago the RPC conducted an extensive outreach to approximately 25 targeted employers, trying to educate them about TDM opportunities and encourage them to implement programs. As part of its TDM efforts, the RPC produced a "Transit Guide" for the Salem, Plaistow, and Windham area to promote the use of transit. This guide provides information on all intercity (interstate) bus service, Massachusetts commuter rail service, carpool and vanpool matching services, and health and human service transportation options in the region.

Massachusetts-based CARAVAN for commuters also provides ride-matching services for New Hampshire residents who work in Massachusetts and Massachusetts' residents who work in New Hampshire. CARAVAN currently has 14 vanpools that travel in the I-93 corridor from Manchester, Londonderry, Windham, Salem, and Plaistow to Boston.

3.2.8.3 Transportation Management Association (TMA) Initiatives

The Manchester Airport TMA was formed in 1994 with CMAQ funds to mitigate traffic impacts associated with airport activity. It is now totally supported by its members,

which include the municipalities of Manchester and Londonderry, the Manchester Airport, the Manchester Transit Agency, the Manchester Chamber of Commerce, Blue Cross/Blue Shield, United Parcel, Felton Brush, Inc., Freudenberg-NOK, Acu-Pak, Mack's Apples, and Stonyfield Farm.

The TMA offers a full range of TDM programs and has formed 20 carpools at Blue Cross/Blue Shield, following its relocation from Concord. Member programs include:

- GIS-based ride-matching for carpools and vanpools
- Information about private bus routes and local bus service providers
- Guaranteed ride home program for employees
- Preferential parking for carpools and vanpools
- Employer consultations regarding transportation and commuting issues
- Employee Transportation Coordinator training
- Quarterly commuter newsletter
- Marketing materials
- Transportation awareness events
- Consultations regarding telecommuting and flexible work arrangements

Massachusetts has a number of TMAs that provide a full range of services to many New Hampshire residents, who work along the I-93 corridor and in Boston. The Massachusetts TMAs that have the greatest likelihood of influencing travel on the I-93 corridor in the study area are:

- The River Road TMA in Andover
- The Junction TMO (Transportation Management Organization) serving the Ballardvale Street and Lowell Junction area in Andover and Wilmington
- The Artery Business Committee TMA in Boston
- Commuter Works/MASCO in Boston (Longwood Medical and Academic Area)
- The Interinstitutional TMA in Boston (Boston Medical Center)
- The Logan TMA at Logan Airport
- The Seaport TMA in South Boston
- The Charles River TMA in Cambridge
- The 128 Business Council TMA

The River Road TMA in Andover estimates that approximately 25 percent of the employees from its member companies live in New Hampshire. As a result, all of its ride-sharing services, which are available to all employees, serve New Hampshire residents. These include ride-matching and guaranteed ride home programs. Further, as described in Proposed Bus Transit Service section below, the Merrimack Valley Regional Transit Authority (MVRTA) has applied for CMAQ funding through the Massachusetts Highway Department to initiate express bus service from southern New Hampshire to the River Road employment area. In April 2002, the NHDOT in a cooperative effort between the Massachusetts Executive Office of Transportation and Construction, the Merrimack Valley Regional Transit Authority, The Junction Transportation Management Organization (TMO), implemented express bus service for New Hampshire employees

working at Wyeth BioPharma in Andover, Massachusetts. The pilot project, which provides for a Guaranteed Ride Home will allow approximately 350 New Hampshire employees an alternative commuting option while helping to reduce traffic on I-93, the local roadways and improving air quality. Many members of Boston TMAs provide support for vanpools and transit ridership, which benefit New Hampshire residents traveling to Boston.

3.2.8.4 Bus Transit Services

No publicly owned bus transit service exists in the I-93 corridor. However, Concord Trailways, a private bus carrier, provides commuter service between southern New Hampshire and Boston and the Merrimack Valley Regional Transit Authority provides a dedicated express commuter service from the I-93 Park-and-ride lots at Exit 3 in Windham and from Exit 4 Park-and-Ride lot in Londonderry to Wyeth BioPharma, a 1600 employee biopharmaceutical company in Andover, Massachusetts. Initial plans for this service anticipated ridership to support up to four morning and evening trips between Wyeth and New Hampshire with a new 40 passenger bus. Currently, only about 6 New Hampshire residents avail themselves of this service to commute to the facility daily. The express commuter service provides one morning departure from New Hampshire to Wyeth and one evening rush hour departure. The mini bus accommodates 16 passengers and two wheelchairs with the service being free for Wyeth employees.

Concord Trailways operates two routes in the I-93 corridor that offer commuter-oriented service between southern New Hampshire and Boston, as well as Logan Airport-oriented service that extends into northern New Hampshire. Service provided is as follows:

Concord-Manchester-Boston-Logan Airport

Southbound, daily, weekday service includes 18 trips that depart from Concord or Manchester between 5:00 AM and 6:00 PM. There are seven trips that pass through the study area during the morning peak commuting period. Scheduled travel time from Manchester to South Station in Boston for these peak period trips varies between one hour and ten minutes, and one hour and thirty minutes. The longest trips include a stop in Londonderry (at Exit 4).

Northbound, daily, weekday service includes 16 trips that depart Logan or Boston for Manchester between 7:15 AM and 9:25 PM. There are seven trips that pass through the study area during the evening peak commuting period. Scheduled peak period travel times from South Station to Manchester vary between one hour, and one hour and fifteen minutes.

Fares between Concord and South Station are $12.50 one-way, $24.00 round trip and $63.00 for a commuter weekly pass. Fares between Manchester and South Station are $10.00 one-way, $19.00 round trip and $56.00 for a commuter weekly pass.

Londonderry-Boston

Southbound, daily, weekday service includes 8 buses that depart Londonderry between 5:40 AM and 8:50 AM. Scheduled travel times vary between 50 minutes, and one hour and ten minutes.

Northbound, daily, weekday service includes 10 buses that depart Boston between 1:00 PM to 8:15 PM. Scheduled travel times vary between fifty-five minutes and one hour.

Fares between Londonderry and South Station are $9.00 one-way, $17.50 round trip and $53.00 for a commuter weekly pass.

Additional Bus Service Along I-93

Three additional Concord Trailways routes provide less frequent service from more northern towns in New Hampshire. This service is oriented toward travel to Logan Airport and includes:

- Laconia-Tilton Jct.-Concord-Manchester-Boston-Logan Airport
  - Southbound, daily, weekday service operates between 7:00 AM and 4:00 PM and provides two morning and one evening bus.
  - Northbound, daily, weekday service operates between 9:15 AM and 7:25 PM and provides one morning and four evening buses.

- Berlin-Conway-Meredith-Boston-Logan Airport – provides one trip each way daily on weekdays with one additional trip on Fridays.

- Littleton-Lincoln-Plymouth-Boston-Logan Airport – provides one trip each way daily on weekdays with additional service when Plymouth State College is in session.

Existing Ridership

Table 3.2-7 presents annual ridership for various segments of Concord Trailways bus routes that serve the southern New Hampshire to Boston market. These routes use the I-93 corridor through the project study area. Annual ridership on Concord Trailways Manchester/Londonderry south routes during 1999 was 265,000 passengers. An additional 115,000 passengers utilized Concord Trailways services originating from Concord south. Services north of Concord carried 45,000 passengers. In total, southern New Hampshire bus services accounted for an estimated 425,000 passengers. None of these services provided interim stops within Massachusetts.

Table 3.2-7
1999 Concord Trailways I-93 Corridor Ridership

Origin	Yearly Ridership
North of Concord	45,000
Concord South	115,000
Manchester/Londonderry South	265,000
Total	425,000

On February 28, 2000 Concord Trailways surveyed their riders to determine the communities from which it draws its ridership. Surveys were conducted at the Londonderry and Manchester bus stops.

Two hundred forty two (242) surveys were tabulated from passengers using the service from Londonderry. Eighty-five (35 percent) of the survey respondents indicated that they lived in Londonderry. An additional seventy-seven respondents (32 percent) were from Derry and the remaining 33 percent came from a number of other surrounding communities.

One hundred twenty six (126) surveys were collected from passengers boarding in Manchester. Nearly two-thirds of the respondents (84) were from Manchester with the remaining respondents coming from several other surrounding communities.

3.2.8.5 Rail Transit Services

Passenger Rail

Two north-south rail corridors exist within the region served by I-93. Corridors include the former Boston and Maine (B&M) New Hampshire Main Line (West Rail Corridor) west of I-93, and the former B&M Manchester and Lawrence Branch (East Rail Corridor) east of I-93 (shown on **Figure 2.3-37)**.

The West Rail Corridor generally parallels US 3 between Manchester, NH and Lowell, MA and the East Rail Corridor generally parallels I-93 between Manchester, NH and Salem, NH. Both rail corridors connect with existing MBTA commuter rail lines in Lowell and Lawrence, respectively.

West Rail Corridor

The West Rail Corridor extends 30 miles from Manchester through Bedford, Merrimack, and Nashua to Lowell, Massachusetts. In the past, passenger rail service was operated by the Boston & Maine (B&M) Railroad from Concord, Manchester, and Nashua to Boston.

The B&M terminated passenger rail service in June 1967. In January 1980, the Massachusetts Bay Transit Authority (MBTA) and New Hampshire Transit Authority (NHTA) inaugurated a demonstration project that offered commuter rail service between Boston and Nashua, Manchester, and Concord. This 13-month program was funded by a federal grant through the United States Department of Transportation. The service reached a peak of 240-250 daily round trips on a schedule that offered a travel time in excess of two hours from Concord to Boston. This demonstration project fulfilled its purpose by identifying the latent demand for rail service in southern New Hampshire. It was discontinued when the funding for the demonstration project was expended.

At present, daily freight traffic is provided along the line by Springfield Terminal Railway (Guilford Transportation Industries or GTI). Service from Lowell to Nashua Yard consists of main line and local freight trains, as well as "unit coal" trains that head north to Bow, NH. Train service north of Nashua consists of trains serving local industries or the unit coal trains serving Bow. Mainline through freight trains also operate between Nashua and Boston in the late evening or very early morning hours. In March 1999, GTI was operating the unit coal train to Bow three days a week. Local freight service was operated daily from the Nashua Yard south to service customers located along the line to Lowell. Similarly, local freight service was offered daily from Nashua to the north.

East Rail Corridor

The East Rail Corridor extends from Manchester through Londonderry, Derry, Windham, and Salem to Lawrence, Massachusetts. The 28-mile corridor is the former B&M Manchester and Lawrence Branch. In the past, when offered, passenger service along the M&L was always limited because of the light population density along the line and the use by the B&M of the New Hampshire Main Line as the preferred through route from Manchester to Boston. Regularly scheduled passenger rail service along the route was discontinued by the B&M in July, 1953. Special passenger trains continued to operate from Boston to Rockingham Park on race days until September 1961.

Today, the M&L Branch sees some limited activity serving freight rail customers between Lawrence and Salem. On the south end, a single track exists from Lawrence to Rockingham Park in Salem. NHDOT is currently in the process of acquiring the remaining 0.95 mile section of the corridor from the Massachusetts border north to approximately the Spicket River that Guilford Rail Systems still owns. This acquisition is important to preserving this corridor for potential alternative transportation needs in the region served by I-93. North of Rockingham Park, the track has been removed for a thirteen-mile section through Windham to Londonderry and the corridor is owned by the NHDOT, but is used as a recreational trail under the control of New Hampshire Department of Resources and Economic Development (NHDRED). From Londonderry to Manchester, the track has been removed and the railroad right-of-way is under State or Municipal ownership with the exception of a 1,500-foot section of the corridor in Derry and Londonderry.

Current Rail Initiatives

Passenger (commuter) rail service is not currently operated into southern New Hampshire. Residents of this area have the option of driving to Massachusetts and parking at existing MBTA stations. In December 2001 the Northern New England Passenger Rail Authority began Amtrak passenger rail service between Portland, ME and Boston, MA. This service includes stops in Exeter, Dover, and Durham, NH.

Over the past two decades, a number of studies have been conducted examining the feasibility of passenger (commuter) rail service between the southern New Hampshire region and Boston, Massachusetts. These studies include:

- "New Hampshire Rail Passenger Demonstration Program," New Hampshire Transportation Authority, 1981
- "Salem Commuter Rail Study," Rockingham Planning Commission, 1984
- "The Southern New Hampshire and Northern Middlesex Commuter Rail Preliminary Feasibility Study," Guilford Transportation Industries, January 1986 (Revised November 1986)
- "Passenger Rail Feasibility Study for the Nashua Area," Nashua Regional Planning Commission, 1988
- "The Passenger Rail Feasibility Study Phase II: Development of Implementation Strategies," Nashua Regional Planning Commission, 1990
- "Commuter Rail Feasibility Study for Manchester NH," prepared for the Southern New Hampshire Planning Commission by Vanasse Hangen Brustlin, Inc., August 1994
- "Technical Memorandum – NHRRA Rail Proposal (I-93 Corridor Commuter Rail)," Salem-Plaistow-Windham MPO Technical Advisory Committee, May 1997 (Revised June 1997)
- "Major Investment Study – Nashua Passenger Rail Service," Nashua Regional Planning Commission, June 1999

The Major Investment Study by the Nashua Regional Planning Commission evaluated restoration of rail service on a 30.6-mile section of the B&M New Hampshire Main Line between Lowell and Manchester (West Rail Corridor). The NRPC and NHDOT selected the extension of commuter rail as the locally preferred alternative, initially extending to Nashua with future extensions to Merrimack, Manchester Airport, and Manchester. The NHDOT began preliminary engineering on the Nashua project in 2001. A legal

challenge to the use of State highway funds for rail projects has delayed completion of the preliminary engineering phase of the project and prevented NHDOT from beginning final design or contracting with the MBTA to order commuter rail cars to be used in the service. The case has been referred to the New Hampshire Supreme Court, and a decision is expected in the spring of 2004.

The environmental assessment process for the Lowell-Nashua commuter rail extension should be completed in early 2004. NHDOT plans to resume negotiations with the MBTA over the operation of the service, and with Guilford Rail Systems for access to the Guilford rail line in New Hampshire. If NHDOT is able to progress with design of track improvements, station and layover facilities, and with obtaining the remaining funding, service could begin to Nashua in late 2006 or 2007. A public hearing on the layout of the rail station/park-and-ride lot was held on June 26, 2003, and construction of the lot is anticipated in 2006. The FTA is requiring development of a new model to forecast ridership on the rail service in comparison with a shuttle bus alternative. The ridership estimates prepared for the environmental assessment were consistent with the 1999 NRPC estimates, a range of 750-900 boardings per day from the station at south Nashua, depending on fare levels and parking fees.

Another study to be undertaken by New Hampshire and Massachusetts jointly is anticipated to begin in 2004. The intent of this I-93 transit study is to evaluate alternative transportation modes and corridors in Massachusetts and New Hampshire as a first step towards implementing a full range of transit services for the region currently served by I-93 from Manchester, NH to Boston, MA. Alternatives include rail and bus services in and along the I-93 highway corridor, the abandoned Manchester-Lawrence rail branch, and alternatives connecting Boston and Manchester via existing MBTA service at Lawrence, the Anderson transit facility, proposed Nashua Rail extension, bus rapid transit or bus-rail combinations. The study will be conducted in four phases and includes the design horizon for the year 2025.

The study is expected to help guide future public and private investment decisions involving alternative corridors and various modes of public transportation.

- Phase 1 is proposed to begin in Spring 2004 and will focus on the identification of institutional issues, service projections, data collection/information gathering and presentation to the public.

- Phase 2 will expand on data collected as part of Phase 1, incorporate public input received and provide an alternatives analysis, culminating in the recommendations for preferred alternatives.

- Phase 3 will include development of a draft report to be presented to the public for comment.

- Phase 4 will result in a final report following consideration of the input received in Phase 3.

Funding has been secured for this study. NHDOT has been coordinating with MEOTC, FTA, and FHWA to refine the scope of work for the study. The process of selecting a qualified consultant to perform this study has begun and the study is anticipated to commence in 2004.

In general, Phase 1 is expected to be completed by late 2004, Phase 2 by Summer 2005, Phase 3 by September 2005, and Phase 4 by Summer 2006. Sequencing and scheduling may be adjusted as the scope of the study and study process are refined. NHDOT will oversee the study through a cooperative agreement with the MEOTC and in cooperation with both FHWA and FTA. A steering committee of the two partner states, FHWA, FTA, USEPA, regional staff from planning commissions from both states, Merrimack Valley, and transit operator representatives will provide oversight, direction, and review for the study.

Other possible locations to reintroduce rail passenger service into New Hampshire include service between Plaistow, NH and Lawrence MA; and between Portsmouth, NH and Newburyport, MA. Once in Massachusetts, passengers would be able to continue on to Boston. Coordination between New Hampshire and Massachusetts officials is on-going. Major hurdles to overcome include finding the necessary funding to make infrastructure improvements in both states.

3.3 Air Quality

This section presents the results of the air quality study, which evaluates impacts from project-related motor vehicle traffic associated with the I-93 roadway improvements. The 1990 Clean Air Act Amendments (CAAA) and the New Hampshire State Implementation Plan (SIP) require that a proposed project not cause any new violation of the National Ambient Air Quality Standards (NAAQS), or increase the frequency or severity of any existing violations, or delay attainment of any NAAQS.

■

3.3.1 Introduction

The air quality study contains a microscale (local) analysis. The microscale analysis evaluated carbon monoxide (CO) concentrations at sensitive receptor locations and changes in CO emissions in the study area from motor vehicles, which are the primary source of CO emissions from the proposed project. The air quality study discusses the proposed project's regional emissions and its compliance with the Transportation Conformity criteria. For traffic-related impacts, the pollutants of interest are carbon monoxide and ozone. The primary concerns are:

- Whether the proposed roadway alternatives will create or exacerbate violations of CO standards, and

- Whether the proposed action will increase or decrease the regional emissions of ozone precursors [primarily volatile organic compounds (VOCs) and nitrogen oxides (NOx)].

The CAAA resulted in states being divided into attainment and non-attainment areas, with classifications based upon the severity of their air quality problems. The proposed project is located in the towns of Salem, Windham, Derry, Londonderry, and the City of Manchester. The City of Manchester was redesignated by the USEPA in November 29, 2000 as being in attainment for CO (see 65 CFR 71060). The USEPA also approved its maintenance plan to insure it remains in attainment. The remaining towns are attainment areas for CO. The towns of Salem, Windham, Derry, and Londonderry are part of the Eastern Massachusetts and Southern New Hampshire ozone non-attainment area, which is classified as "Serious." The City of Manchester is located in the Manchester ozone non-attainment, which is classified as "Marginal."

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3.3.2 Mobile Source Analysis

The air quality study was prepared consistent with U.S. Environmental Protection Agency (USEPA) modeling procedures. The microscale analysis calculated maximum CO concentrations at receptor locations for each intersection for existing (1997), the estimated year of completion (2010), and design (2020) years for the No-Build and Build Alternatives. The traffic (volumes and speeds) and emission data were developed for each alternative. The local air quality impacts of the proposed project were calculated based on these data. The 1997 existing condition reflects current traffic conditions in the study area. The 2010 and 2020 No-Build Alternatives reflect the existing traffic volumes increased to account for anticipated background traffic volume growth. The 2010 and 2020 Build Alternative volumes reflect the future No-Build Alternative traffic volumes plus the changes in traffic distribution caused by this I-93 project.

3.3.2.1 Emissions: Mesoscale Analysis

A total burden analysis was completed for inclusion in the "Fiscal Year 2003-2005 Conformity Determination for Transportation Improvement Programs, Transportation Plans, and Regional Emission Analysis of Transportation Projects." The Conformity document was reviewed by the USEPA and the USDOT and approved by the USDOT in November 2002. The proposed layout of the widening of I-93 to 4 lanes in each direction, as embodied in the Selected Alternative, was included as part of this Conformity Determination. Therefore, a regional analysis outside of that completed for the conformity determination is not necessary.

3.3.2.2 Microscale Analysis

Dispersion Model

The microscale analysis was conducted utilizing the CAL3QHC[25] Version 2 model for free flow and intersection roadway links. CAL3QHC is recommended by the USEPA and is required by USEPA Region I for the air quality analysis of major congested intersections. The effect and extent of vehicle queuing on CO levels at each intersection is determined by CAL3QHC at the intersection of analysis by evaluating the following input; the MOBILE5b[26] idle emission rates, exhaust emission factors, total signal cycle time, effective red time, volumes, roadway geometry, and capacity of intersection. The data are used to develop queuing links at approaches of each analysis site.

Analysis Sites

The USEPA has set the NAAQS for CO to protect the public health. The NAAQS for CO is 35 parts per million (ppm) for a 1-hour period and 9 ppm for an 8-hour period, each not to be exceeded more than once per year. The predominant source of pollution anticipated from the proposed project is emissions from project-related motor vehicle traffic. CO is directly emitted by motor vehicles and its concentration can be estimated by computer modeling.

The objective of the microscale analysis was to evaluate the CO concentrations at congested intersections in the study area during the peak CO season (winter). The intersections in the study area were ranked based on traffic volumes and level of service under the various Build Alternatives. The following intersections (depicted in **Figures 3.3-1, Sheets 1 through 4**) were selected for analysis because they represent the most congested intersections that are most likely to be affected by project-related traffic in the study area:

- I-93 Exit 2 southbound off-ramp, Pelham Road (NH 97), and Keewaydin Drive
- I-93 Exit 2 northbound off-ramp and Pelham Road (NH 97)
- I-93 Exit 3 northbound off-ramp at NH 111
- Fordway and NH 102
- Route 28A at Huse Road
- Route 28A at Cilley Road
- Route 28A at Candia Road
- Route 28A at Massabesic Road

[25] User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections, US Environmental Protection Agency, Office of Air Quality Planning and Standards, Technical Support Division; Research Triangle Park, NC; EPA-454/R-92-006; November 1992.

[26] The September 14, 1996 release of MOBILE5b (Mobile Source Emission Factor Model), USEPA, Office of Mobile Sources, Ann Arbor, MI.

A ninth location, representing the highway right-of-way, was also included in the analysis. A receptor was located along the right-of-way south of Exit 1, where the highest traffic volumes on the I-93 mainline occur.

The microscale analysis calculates maximum 1-hour and 8-hour CO concentrations in the project area. The USEPA's CAL3QHC computer model was used to predict CO concentrations at receptor locations. The CAL3QHC pollution dispersion model calculates the air quality impacts from vehicles in both free-flow and idle operation by creating a three-dimensional model that represents the roadway and receptor geometry. Traffic, emission, and meteorological data were entered into the model to predict maximum 1-hour CO concentrations at the receptor locations. The receptor locations were placed in areas where the public has access. Typically, the receptor locations were placed at the edge of the roadway, but not closer than 10 feet (3 meters) from the nearest travel lane, so that they were not within the roadway mixing cell. The microscale analysis evaluated over 100 receptor locations near the intersections. Of these receptor locations, 30 sensitive receptors were selected in the study area to represent the receptor locations. These sensitive receptors are shown on **Figure 3.3-1, Sheet 3**. The results of the microscale analysis are presented in Tables 4.3-1 and 4.3-2. These values represent the highest concentrations for each quadrant of each intersection. Receptor locations located farther away from the intersections will have lower concentrations because of the CO dispersion characteristics. Receptors that are along major roadways (I-93) are also expected to have lower CO concentrations, because the emission factors for vehicles traveling along these roadways are much lower than the emission rates for vehicles queuing at intersections.

The 1-hour CO concentrations were calculated directly from the USEPA computer model, using peak hour traffic and emission data. The 8-hour CO concentrations were derived by applying a persistence factor of 0.7 to the 1-hour CO concentrations. USEPA recommends the use of a 0.7 persistence factor when monitoring data for a local area are not available.

Emission Factors

The vehicle emission factors used in the microscale analysis were obtained using the USEPA MOBILE5b computer model. MOBILE5b calculates CO emission factors for motor vehicles in grams per vehicle-mile. The emission factors calculated in this study were adjusted to reflect New Hampshire-specific conditions such as temperatures representative of the winter CO season (30^0 F). The detailed MOBILE5b input and output data are available upon request.

Worst Case Meteorological Conditions

The worst case meteorological conditions, including wind speed, stability class, ambient temperature, and persistence factor were selected and utilized for the microscale analysis peak one-hour period as follows:

- Wind Speed: 3.3 feet/second
- Wind Direction: Worst Case wind angle search
- Wind Angles: 10 degrees increments from 0 to 360 degrees
- Stability Class: D
- Temperature: 30 degrees Fahrenheit
- Mixing Height: 3,280 feet

CO Background Values

The CO concentrations presented in the results include background CO concentrations. The background concentrations are the constant and diffuse levels of CO that is typically present due to numerous sources throughout the area. A background CO concentration of 2.0 ppm was used for both the 1-hour and 8-hour analysis.

■

3.3.3 Model Predictions

The microscale analysis demonstrated that the 1997 1-hour CO concentrations ranged from a minimum of 4.2 parts per million (ppm) at the highway right-of-way to a maximum of 12.0 ppm, which occurred at the intersections of Route 28A at Huse Road, Route 28A at Cilley Road, and Route 28A at Candia Road. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 3.5 ppm to a maximum of 8.4 ppm. The microscale results for all the receptor locations are presented in Tables 4.3-1 and 4.3-2. All the 1-hour and 8-hour concentrations are below the CO NAAQS of 35 and 9 ppm, respectively.

3.4 Water Resources

Surface water resources within the study area consist of lakes, ponds, streams, and the watersheds that drain into them. Existing water quality conditions and their designated uses are protected by the surface water quality regulations (Env WS 1700) administered by the New Hampshire Department of Environmental Services, Water Division. Surface water resources are classified as either Class A or B depending on the designated uses and water quality conditions in the water body. Nearly all major surface water resources within the study area are classified B with the exception of Canobie Lake and its tributaries. Class A waterways are considered potentially acceptable as a water supply after adequate treatment, and no discharge of sewage or wastes is permitted in this classification. Class B waterways are considered suitable for fishing, swimming, and, after adequate treatment, as a water supply.

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3.4.1 Surface Water Resources

3.4.1.1 Watersheds

The following five major watershed areas are located within the study area and are shown on **Figure 3.4-1**:

- Spicket River Watershed,
- Golden Brook Watershed,
- Beaver Brook Watershed,
- Little Cohas Brook Watershed, and
- Cohas Brook Watershed

South of Exit 3, much of the existing I-93 roadway is in the Spicket River watershed and crosses a number of tributary streams. Between Exits 3 and 4, a major portion of the existing I-93 roadway is located near the major drainage divide between the Golden Brook watershed and the Spicket River watershed and then enters the Beaver Brook watershed just south of Exit 4. A section of the roadway just south of Exit 5 and a small portion just north of Exit 5 is within the upper reaches of the Little Cohas Brook watershed. However, neither the Little Cohas Brook nor any of its tributaries are actually crossed by or located directly adjacent to the existing I-93 roadway. The remaining roadway, north of Exit 5, is located within the Cohas Brook watershed.

3.4.1.2 Lakes and Ponds

This section identifies lakes and ponds that may be impacted by the highway improvements identified by this project (**Figure 3.4-1**). Canobie Lake and Cobbetts Pond are the largest and perhaps the most important lakes in the study area. Both are extensively used for recreation purposes and Canobie Lake serves as the primary water supply source for the Town of Salem. Both of these lakes, or major portions thereof, are located in the Town of Windham just south of Exit 3 Interchange and are adjacent to and downgradient to large portions of the I-93 roadway.

Canobie Lake

Canobie Lake is located east of I-93 between Exits 2 and 3 on the Windham/Salem town line. This Lake, and its tributaries, are classified as a Class A waterbodies and the Lake currently serves as the primary water source for the Town of Salem, at least during the summer months. From October to May, the Salem Water Department primarily draws water from the Arlington Mill Reservoir, which is located about one mile east of Canobie Lake. The water intake and pumping station are located on the northeast shore. In July 1995, a new filtration treatment plant was completed for added protection against pathogens and other microorganisms. Canobie Lake has a watershed area of

approximately 1400 acres, an estimated surface area of about 373 acres and a maximum depth of 44 feet (NAI 1998). It appears to be fed mostly from groundwater with limited surface water inputs from two small streams draining from the west along I-93 and two small streams draining from the north. Much of its shoreline is extensively developed with homes including an amusement park that exists on the south east shore. Approximately 6,500 feet of the existing I-93 roadway in between the Brookdale Road overpass and the Exit 3 Interchange are located within the watershed. The two tributary streams originate along this stretch of roadway and drain into Canobie Lake. These streams are referred to as the south tributary and the north tributary to Canobie Lake (**Figure 3.4-1**). The outlet of Canobie Lake is Policy Brook, which is located on the east shore.

Since the summer of 2002, Canobie Lake has become part of the of the New Hampshire Department of Environmental Services (NHDES) Volunteer Lake Assessment Program (VLAP). The VLAP personnel train members of lake associations and other volunteers to conduct periodic (i.e., monthly) water quality sampling and limnological measurements. One sampling event was conducted in September, 2002. Based on the results, the total phosphorus concentrations in the surface and deep water layers were reported to be about 6.0 and 18.0 parts per billion (ppb), respectively. The median summer phosphorus concentrations for the surface and deep water layers in New Hampshire lakes are reported to be 12.0 and 14.0 ppb, respectively. Chlorophyll *a*, which is an indicator of algae abundance, was reported to be at about 4.0 ppb, which was below the statewide average of 7.02 ppb for NH lakes and ponds (NHDES 2002a).

Previous monitoring data collected by the UNH Freshwater Biology Group back in the summer of 1994 showed similar results. Total phosphorus concentrations typically ranged from 6.0 to 12.0 ppb in the surface water layers and from around 15 to 25 ppb in the bottom layers with one measurement being as high as 42 ppb at depth of 15 to 16 meters (49 to 52 feet). The one high reading could indicate that the bottom sediments may be releasing phosphorus during anoxic (i.e., low-oxygen) conditions or it could be due to an increase in turbidity caused by a disturbance of bottom sediments during sampling. Low dissolved oxygen levels were also detected at a depth. The seasonal chlorophyll *a* level was reported to be 3.9 ppb at a central deep lake location and 3.4 ppb at a southerly station and 2.8 ppb at a northerly station. Chlorophyll *a* concentrations of 3.0 to 7.0 ppb are considered typical of lakes with moderate amounts of algal productivity. Concentrations below 3.0 ppb are common to less productive, clear lakes and concentrations above 7.0 ppb are typical of the more productive lakes. UNH biologists noted the presence of free-floating and attached "mats" of nuisance green algae (*Mougeotia* sp.) on most sampling dates. Canobie Lake is considered to be mesotrophic but trending slightly towards eutrophic conditions (J. Schloss, Pers. Comm. UNH Biology Group, March 2002).

Cobbetts Pond

Cobbetts Pond is located just west of Canobie Lake and on the west side of I-93, just south of the Exit 3 Interchange. It has a surface area of approximately 345 acres and a

watershed of about 2,050 acres. The lake is relatively long and narrow with a length of nearly 2.0 miles and a maximum width of less than a 0.5 mile. Consequently, it has two distinct northern and southern deep water sections. The northern section is closest to I-93 and has a maximum depth of about 50 feet and a variable width of about 1,000 to 1,500 feet. The southern portion is the larger of the two sections with a maximum width of 2,500 feet and a maximum depth of about 60 feet. The northerly and southerly sections are separated by narrow section that is roughly 600 to 700 feet wide and about 20 feet deep (NHDES 2001).

Cobbetts Pond is a highly regarded recreational resource in the area. Much of its shoreline is developed with year-round and seasonal homes that are serviced by onsite septic systems. Similar to Canobie Lake, its surface water inputs are limited to one or two tributary streams. Its primary surface water inflow comes from a stream at the northern end, locally referred to as Dinsmore Brook, which originates about one mile northeast of the Exit 3 Interchange near Gov. Dinsmore Road. Runoff from much of the Exit 3 Interchange area, including the on and off-ramps and portions of the I-93 mainline drain into this stream and eventually to the Pond. In addition, about 0.75 mile of NH 111, west of the interchange, is also within the Pond's watershed.

Cobbetts Pond has been sampled during the summer months since 1988 as part of the NHDES Volunteer Lake Assessment Program (VLAP). The lake is generally sampled in both the deep water sections at the southern and northern ends of the lake. The 2002 Bi-Annual Report indicates that Cobbetts Pond had an average phosphorus concentration in the surface water layers of about 10.0 ppb, and an average chlorophyll *a* concentration of about 4.0 ppb. A phosphorus concentration of 10 ppb or less and a chlorophyll *a* concentration of less than 5.0 ppb is generally considered to be representative of good water quality conditions and low algal productivity (NHDES 2001b). These average concentrations are also lower than the median phosphorus concentration of 12 ppb and the average chlorophyll *a* concentration of 7.02 ppb observed in New Hampshire lakes. Deep water samples showed higher phosphorus concentrations that ranged between 20 to 40 ppb, which are more typical of mesotrophic or moderately productive lakes. The higher phosphorus concentrations in the bottom layers could be due to internal releases from bottom sediments during anoxic conditions. However, both the 2001 and 2002 annual data reports noted that higher turbidity readings were observed in the deep water samples and these readings may have been due to disturbances of the bottom sediments as the sampling apparatus was lowered. The higher turbidity could have contributed to the higher phosphorus concentrations (NHDES 2002b and 2001b).

A statistical analysis of the historical data going back to 1988 suggests that phosphorus levels have remained stable in the surface waters but have significantly increased in the bottom layers over the 14 year period (NHDES 2002b). However, the seasonal average phosphorus concentration varies greatly from year to year in both the surface and deep waters and has ranged from 4.0 to 17.0 ppb in the surface water layer and from 7.0 to 27.0 ppb in the deep water layers. Historically, the chlorophyll *a* levels were considered to have significantly increased in the southern section of the lake but not in the northern section. Dissolved oxygen data reveals that generally there is little to no dissolved

oxygen below 10 meters (33 feet) and 17 meters (51 feet) in depth in the northern and southern sections of the lake, respectively. The historical data also show slightly higher specific conductance levels of roughly 270 to 350 microseimens per centimeter (µs/cm) and as high as 470 µs/cm in the northern section of the lake as compared to a range of 240 to 306 µs/cm observed in the southern section of the lake. In addition, at the northern end of the lake, there tends to be a greater difference in the specific conductance levels measured in the upper surface waters as compared to the deep waters. In some years, the difference has been as much as 150 to 170 µs/cm, which may be indicative of the inputs from the I-93 roadway and particularly the Exit 3 Interchange, which as mentioned earlier is almost entirely within the Pond's watershed.

Similar to Canobie Lake, Cobbetts Pond, in general, has shown good water quality conditions, low and moderate amounts of algal productivity but is susceptible to declining water quality conditions and higher algal productivity with increased phosphorus inputs.

Crystal Lake

Crystal Lake is located approximately 1,000 feet west of I-93 just south of the junction with I-293 in Manchester and is used for recreational purposes by the City of Manchester. The lake is approximately 19 acres in size and includes a municipal beach at its southeastern end. The NHDES has categorized this lake as being eutrophic, meaning it has relatively high levels of algal and nuisance weed growth presumably due to the nutrient inputs from the watershed (Estabrook, 1990). Much of the area immediately surrounding the lake is extensively developed with numerous residential homes. According to NHDES, approximately 1,800 feet of the I-93 southbound lanes are in the watershed. However, there is no apparent stream that flows from the I-93 area directly to the lake. The outlet of Crystal Lake drains to Cohas Brook.

Other Ponds

There are several small ponds that are located adjacent to I-93 that are less than 10 acres in size. These include a small, unnamed pond near North Lowell Road in Windham, Wheeler Pond near Exit 4, and an unnamed pond just north of Exit 5. Since they are less than 10 acres in size, they are not classified as Great Ponds and are not listed as public water bodies according to the NHDES. However, NHDES still considers these water bodies to be surface waters of the State. These small ponds may be remnants of historic excavation activity in sand and gravel areas.

3.4.1.3 Streams and Tributaries

Twenty-one (21) streams, rivers and tributaries were identified within the project area. The project area consists of a 4,000-foot wide corridor centered over the existing I-93 roadway from just south of the Massachusetts border north to the I-293/I-93 Interchange. The project area contains several moderate to large streams and many small tributary streams. The two largest streams include the Spicket River and Beaver Brook, which have estimated

watershed areas of well over 10.0 square miles. These streams represent the major river systems in the project area and are fed by many of the smaller tributary streams in the area. There are two moderately sized streams including Policy Brook and Porcupine Brook that are located in the southern end of the project area and have estimated watershed areas of 2,500 to 3,200 acres or about 3.0 to 5.0 square miles. Cohas Brook, at the northern end of the project area, is also considered to be a moderate-size stream with an estimated watershed area of about 5,000 acres or 8.0 square miles. The other streams in the project area are generally much smaller and are primarily tributary or headwater streams with estimated watershed areas of less than 640 acres or 1.0 square mile in size.

As discussed earlier, the existing I-93 roadway from Salem to Manchester traverses through five (5) major watershed areas (Section 3.4.1.1). The following provides a more detailed description of the perennial streams within the project area that are crossed or located directly adjacent to the existing roadway, starting in the south and progressing northward.

In addition, during the winter and spring seasons of 2002/03, an extensive sampling study was conducted by NHDOT to document the existing chloride and specific conductivity levels in selected streams in the project corridor and to evaluate the effects of road salt applications on the I-93 roadway. Fourteen streams were sampled downstream of the I-93 roadway and ten of these streams were also sampled upstream of the I-93 roadway. The sampling locations for each stream are illustrated on **Figure 3.4-1**. Streams included in the study were primarily those that had relatively safe access from secondary roads. Gaining access from the I-93 roadway was considered hazardous especially during winter months.

Sampling was conducted twice per month over the course of six months from December 2002 to May 2003. During each event, specific conductance levels were measured in the field and water quality samples were collected for chloride analysis. NHDES has established surface water quality standards for chloride at concentrations of 230 and 860 mg/l, for chronic and acute aquatic life protection, respectively. A recent US Geological Survey study found that specific conductance levels of 850 and 2,855 µs/cm generally correspond to chloride concentrations of 230 and 860 mg/l, respectively (Granato and Smith, 1999). During the 2002-2003 season, NHDES and USEPA collected continuous specific conductance data, measured every 15 minutes, using data loggers in the Spicket River, Policy Brook, Beaver Brook and Cohas Brook. Additional specific conductance monitoring was continued into the 2003-2004 winter season for specific streams. The following sections present both the 2002-2003 and the preliminary 2003-2004 specific conductance data using continuous data loggers. Additional data will be collected through mid-April 2004.

Table 3.4-1 presents the average specific conductance levels and chloride concentration for each stream sampled in 2002-2003 and the percent difference between the upstream and downstream stations, where available. The amount of I-93 roadway area in each watershed as a percentage of the watershed area is also provided. A complete

Table 3.4-1
I-93 Road Salt Sampling Study Results[1] (12/2002-5/2003)

Map Location No.[2]	Stream	RA/DA[3]	Average Specific Conductance(µs/cm)[5]		Percent Difference	Average Chloride Conc. (mg/l)		Percent Difference
		%	up[4]	down		up	down	
1	Spicket River	0.1	357	443	24%	91	119	31%
2	Policy Brook	0.3	652	759	16%	187	213	14%
3	Trib to Harris	4.2	497	565	14%	143	149	4%
4	S. Trib to Canobie	4.4	191	336	76%	35	85	143%
5	N. Trib to Canobie	3.4	ns	773	na	ns	218	na
5C	N'east Trib to Canobie reference	na[6]	ns	701	na	ns	198	na
6	Searles Rd Trib-reference	na[6]	ns	309	na	ns	68	na
7	Dinsmore Brook	9.6	162	554	242%	14	154	996%
8	N. Trib to Golden Brk	3.4	ns	316	na	ns	67	na
9	Trib- Flatrock Brk	1.3	na	347	na	ns	77	na
10	S. Trib-Beaver Brk	1.7	343	418	22%	88	97	10%
10C	N.Trib-Beaver Brk	2.7	ns	266	na	ns	55	na
11	Beaver Brook	0.1	360	371	3%	98	99	1%
12	Trib-Wheeler Pond	3.2	431	555	29%	107	133	25%
13	Trib to Hood Pond	1.5	264	318	20%	61	71	17%
14	Little Cohas Brook[7]	3.5	195	297	52%	38	85	123%
15	Cohas Brook	0.8	193	265	37%	40	66	64%

Notes:
1 Based on samples collected twice per month by NHDOT from December 2002 to May 2003.
2 See **Figure 3.4-1** for locations.
3 Represents the ratio of I-93 roadway area to the drainage area expressed as a percentage.
4 Up and down refer to upstream and downstream of I-93 roadway.
5 Specific conductance levels above 850 and 2,855 µs/cm max indicate a potential exceedance of the chronic and acute aquatic life criteria of 230 and 860 mg/l, respectively.
6 These streams are not affected by I-93 roadway drainage and were used as reference streams.
7 Little Cohas Brook is crossed by NH 28 but not I-93.
ns Not sampled.
na Not applicable.

description of the 2002-2003 study results can be found in a separate report entitled, "Road Salt Constituent Monitoring Program, Data Summary Report, July 2003" (NHDOT 2003). This effort was coordinated with NHDES and USEPA who collected the additional specific conductance data in 2002-2003, which is also presented in the above referenced report.

Spicket River

The Spicket River is located at the southernmost end of the study area, near the Massachusetts/New Hampshire border and is the largest stream in the study area. It has an estimated watershed area of 64.2 square miles at the point where it flows beneath Hampshire Road near the state border and includes most of the land area within the Town of Salem, much of the easterly portions of the Town of Windham, and extending as far north as the eastern portions of Derry. It receives minimal direct runoff from I-93, but about 5.5 miles of the existing I-93 roadway, from the state border to just south of Exit 3, are in its watershed. Various portions of I-93 drain into its tributaries including Policy Brook, Harris Brook and Porcupine Brook and are discussed below. The Spicket River empties into the Merrimack River after it flows over a dam in Methuen, Massachusetts about 2.0 miles south of the state border.

The Spicket River has been prone to flooding during previous large storm events, particularly along Haigh Avenue in Salem. The U.S. Geological Survey has recently installed a permanent flow gage at the Hampshire Road bridge to provide real-time flow data that will allow for improved monitoring of peak flow conditions. The downstream dam in Methuen, Massachusetts creates backwater conditions and raised water levels upstream, as far north as just beyond its confluence with Policy Brook in Salem, New Hampshire. The downstream stream course appears to have been realigned where it passes through the I-93/US-213 interchange in Massachusetts.

The results of the 2002-2003 sampling study indicate that the average specific conductance levels upstream and downstream of I-93 were 347 and 443 microseimens/centimeter (µs/cm), respectively. The average upstream and downstream chloride concentration was 91.0 and 119 mg/l, respectively, which represents a difference of about 30 percent. The continuous specific conductance data collected by NHDES during the 2002-2003 season indicated a peak conductance level of 1,800 µs/cm, which suggests a short-term exceedance of the chronic criteria. For the 2003-2004 season, the preliminary data indicates an average upstream specific conductance level of 372 µs/cm, which is slightly above the previous year's average of 347 µs/cm. During a mid-winter rainfall/runoff event, a peak 4-day average specific conductance level of 688 µs/cm was preliminary reported for the upstream station. Additional measurements will be collected through mid-April 2004.

Tributary to Harris Brook

Just north of the state border, a small tributary to Harris Brook parallels along the west side of the existing I-93 roadway for about 3500 feet before emptying into Harris Brook which is located south of the state border. This tributary has an estimated watershed area of about 330 acres based on a review the USGS topographic map. It appears that runoff from nearly a mile of the existing I-93 southbound lanes, from a point just south of Exit 1 drains into this brook. Much of its watershed contains residential areas along Cross Street, Hampshire Road, Salem Street and Brady Road on the west side of I-93.

The results of the 2002-2003 road salt sampling study indicate that there was only a 4 percent difference between the average upstream and downstream chloride concentrations of 143 and 149 mg/l, respectively. The average upstream and downstream specific conductance levels were 497 and 565 µs/cm, respectively. The levels upstream of the I-93 roadway were already elevated due to other sources in the watershed, which may include septic system leachate, use of water softeners and road salt applications on municipal roadways (NHDOT 2003).

Policy Brook

Policy Brook flows parallel along the east side of I-93 within 500 feet of the northbound lanes for about 1.0 mile from just north of the northbound Salem Rest Area, until it empties into the Spicket River about 800 feet north of the state border. Policy Brook originates as the outlet of Canobie Lake and has an estimated drainage area of about 3,500 acres in size. A short section of the I-93 roadway just north of Exit 2, near the CISCO manufacturing plant also drains into Policy Brook. It flows south through much of the commercially developed areas along North Policy Road, Pelham Road, South Policy Road, and Rockingham Park Boulevard. The amount of impervious area associated with the Rockingham Mall and the adjacent Rockingham Park race track property alone is estimated to consist of well over 100 acres. Just north of Rockingham Park, the stream flows through a series of culverts and then daylights on the south side, where it is joined by Porcupine Brook.

The 2002-2003 sampling results indicated that the average upstream and downstream specific conductance levels were 652 and 759 µs/cm, respectively. While the average upstream and downstream chloride concentrations were 187 and 214 mg/l, respectively. Again, the difference between the upstream and downstream concentrations was relatively small or 14 percent, indicating that upstream concentrations are already elevated. The continuous specific conductance level collected by NHDES in 2002-2003, showed specific conductance levels typically exceeded 850 µs/cm for most of February 2003. Additional data recorded by USEPA in April 2003, farther up in the Policy Brook watershed, east of Route 28 and outside of any influence of major roadways or commercial areas, showed that the specific conductance levels ranged between 540 and 689 µs/cm, which were not much different than downstream levels of 637 µs/cm and 726 µs/cm measured at Cluffs Crossing Road and the Salem Rest Area along I-93, respectively (NHDOT 2003). These results suggest that the elevated specific conductance levels are more of a regional issue and not just due to the I-93 road salt applications. The preliminary sampling results for 2003-2004 winter season confirm relatively high specific conductance levels in an upstream tributary to Policy Brook. Continuous readings recorded from mid-December 2003 to mid-March 2004 in this upstream tributary indicate an average specific conductance level of 1,200 µs/cm and a peak 4-day average of 3,034 µs/cm. Additional measurements will be recorded through mid-April 2004.

Tributary to Porcupine Brook

The tributary to Porcupine Brook is a small stream that originates just west of the Exit 1 Interchange and flows through the southern half of the interchange area and then

easterly crossing beneath Rockingham Park Boulevard before joining up with Porcupine Brook. It appears that this tributary may be fed by the groundwater discharge from the large stratified-drift aquifer in this area. Its watershed is estimated to be about 350 acres and is likely to receive a fair amount of roadway runoff from the Exit 1 Interchange and Rockingham Park Boulevard. This stream was not sampled as part of the 2002-2003 sampling study due to the lack of good access from a secondary road.

Porcupine Brook

Porcupine Brook originates in the southeast portion of Windham within a large wetland complex just south of Cobbetts Pond. A portion of the existing I-93 roadway near the Windham/Salem town line drains to this large wetland area. The main channel of the brook develops in Salem and flows south, entering the project area from the west about 0.75 mile north of Exit 1 crossing beneath the southbound lanes. The brook then flows within the existing I-93 median area for about 1,800 feet before crossing beneath the northbound lanes near the Lowell Road underpass. Porcupine Brook then flows along the east-side of the northbound lanes and the base of the northbound on-ramp embankment and then along Rockingham Park Boulevard before turning south under Rockingham Park Boulevard and joining with Policy Brook. The original stream channel has likely been modified and relocated as part of the original I-93 construction, the construction of Rockingham Park Boulevard and the Rockingham Mall. Porcupine Brook appears to be fed by groundwater discharge associated with a large stratified-drift aquifer that exists in this area (See Groundwater Resources in Section 3.4.2). Its watershed area is estimated to be about 2,500 acres in size and includes an unnamed tributary that originates in the infield area within the west side of the Exit 2 interchange. This tributary crosses beneath the I-93 southbound and northbound lanes and joins up with Porcupine Brook about 0.4 miles south of Exit 2. This stream was also not sampled as part of the 2002-2003 sampling study.

South Tributary to Canobie Lake

The south tributary to Canobie Lake represents one of two small streams that originate just west of the existing I-93 roadway and flow into the west side of Canobie Lake. This tributary flows into the southwest corner of the lake about 500 feet downgradient of I-93. As discussed earlier, Canobie Lake is one of two primary drinking water supply sources for the Town of Salem. The lake is primarily used for water supply during the summer months. The pumping station used to draw water for the public water supply is located on the opposite, or northeast, side of the lake. The watershed area associated with this tributary is relatively small consisting of about 165 acres in size and includes about 2,000 feet of the existing I-93 roadway. Of the streams studied, this stream had the second highest percentage of I-93 roadway area in its watershed. Dinsmore Brook had the highest percentage and is discussed below.

This stream was sampled both upstream and downstream of the I-93 roadway during the 2002-2003 sampling study. The average upstream and downstream specific conductance levels for the six month period were 191 and 336 µs/cm, respectively. The average upstream and downstream chloride concentrations were 35 and 85 mg/l, respectively

(NHDOT 2003). Although the percent difference between the upstream and downstream concentrations was relatively high, the average downstream concentration was relatively low and not much higher than that observed in the reference stream, Searles Road Tributary, which has no I-93 roadway area in its watershed. These results are surprising given that this stream has a relatively high percentage of I-93 roadway area in its watershed.

North Tributary to Canobie Lake

About 3,000 feet further north and just south of Exit 3, near the NH 111A underpass, another small intermittent stream originates within the median area near NH 111A and the I-93 northbound lanes and drains into a northwest cove of Canobie Lake. Similar to the south tributary of Canobie Lake, about 2,500 feet of the existing I-93 roadway is estimated to be within this watershed.. This stream is also similar in size as the south tributary with an estimated watershed of about 160 acres and is considered to support only seasonal, intermittent flow.

This stream was sampled only downstream of I-93 since an accessible upstream sampling location could not be established. This stream had some of the highest specific conductance levels and chloride concentrations of any of the streams sampled. The average specific conductance level and chloride concentration was 773 µs/cm and 218 mg/l, respectively. These high readings are difficult to explain given that the south tributary to Canobie Lake, which has essentially the same amount of I-93 roadway in its watershed and the same size watershed, had specific conductance levels and chloride concentrations that were less than half of that observed in the north tributary. Also, Dinsmore Brook (see below) as a percentage of its watershed area has 3 times more I-93 roadway area, including nearly all of the Exit 3 Interchange, and the specific conductance and chloride levels were also much lower in this stream. The 2002-2003 sampling results suggest that there may be another substantial source of chloride in the watershed. The fact that some of the highest levels were observed in April and May, after the deicing season, which was in contrast to all other streams sampled, further supports the theory of another major source in the area. One possibility could be related to the potassium chloride used to treat the water in the nearby Pennichuck Water Works community well, located several hundred feet away. The onsite treatment system has been used for many years and the high chloride-laden backwash from the treatment system is apparently discharged into a dry well onsite, which eventually would make its way into the regional groundwater (NHDOT 2003).

The Northeast Tributary to Cobbetts Pond – Dinsmore Brook

The northeast tributary to Cobbetts Pond, locally referred to as Dinsmore Brook, represents the principal surface water input to Cobbetts Pond. Cobbetts Pond is considered to be primarily fed by groundwater discharge and to a lesser extent by surface water inputs. This tributary has two branches with the main branch originating about one mile northeast of Exit 3, flows through the Exit 3-Interchange area and into the northeast corner of Cobbetts Pond. Another smaller branch originates to the north of Exit 3 within the median area of I-93. The entire watershed area is estimated to be about 200 acres in size and includes about 1.0

mile of the I-93 roadway and another 0.8 mile of NH 111 and most of the southbound on and off ramp area, associated with Exit 3.

This stream was sampled both upstream and downstream of the I-93 roadway during the 2002-2003 sampling study. The average upstream and downstream chloride concentrations were 14 and 154 mg/l, respectively. The relatively low concentrations observed upstream were in part due to the sampling location being so high up in the watershed at a point basically where the stream originates as a groundwater seep. The large difference between the average upstream and downstream concentrations is also due in large part to the amount of I-93 roadway, including nearly the entire Exit 3 Interchange area, being within its watershed. Even with the large amount of I-93 roadway in its watershed, there was only one event where chloride concentration exceeded 200 mg/l. This is in contrast to other streams, such as the north tributary to Canobie Lake and Policy Brook, where the observed chloride concentration exceeded 200 mg/l on several events. In the case of Policy Brook, the high concentrations were observed both upstream and downstream of I-93, as discussed previously. The preliminary specific conductance readings recorded during the 2003-2004 winter season indicate an average specific conductance level in Dinsmore Brook of 651 µs/cm and a peak 4-day average level of 1,416 µs/cm. Additional measurements will be recorded through mid-April 2004.

South Tributary to Golden Brook

About 1.0 mile north of Exit 3, another small tributary appears to originate within 200 feet of the southbound lanes at a location opposite Jenny's Hill. Its watershed includes about 2,000 feet of I-93 roadway just west of Jenny's Hill. It flows in a southwesterly direction and is joined by the north tributary to Golden Brook before crossing through the central village portion of Windham along NH 111 and eventually joins with Golden Brook below the outlet of Cobbetts Pond. Its watershed, upstream of I-93, is estimated to be about 210 acres in size. This stream was not sampled as part of the 2002-2003 sampling study due to the lack of good sampling access.

North Tributary to Golden Brook

A little further north, another tributary to Golden Brook originates near the existing I-93 roadway. The stream channel associated with this tributary appears to begin within a large wetland area located just east of the northbound lanes. Its watershed is slightly larger than the south tributary, discussed above, and is estimated to include about 290 acres, upstream of I-93. About 4,000 feet of the existing I-93 roadway is estimated to be within its watershed. As mentioned earlier, this north tributary meets up with the south tributary and eventually flows into Golden Brook, below the outlet of Cobbetts Pond. This stream was sampled downstream of the I-93 roadway during the 2002-2003 sampling study, but an accessible upstream sampling location could not be found. The results show that the average specific conductance level and chloride concentration in this stream downstream of the highway was 316 µs/cm and 67 mg/l, respectively. These results are similar to the results recorded in the reference stream, namely the Searles Road tributary, which has no I-93 roadway area in its watershed (NHDOT 2003).

South Tributary to Flatrock Brook

About 2.3 miles north of Exit 3, near where North Lowell Road crosses beneath I-93, a small headwater tributary to Flatrock Brook appears to originate just west of the I-93 southbound lanes. This stream begins in a wetland area around a small pond, about 1.0 acre in size, on the west side of I-93. It then flows in an easterly direction beneath I-93 and beneath Morrison Road and then into Mitchell Pond, which is about 1.0 mile east of I-93. The main stem of Flatrock Brook appears to begin below Mitchell Pond. The upstream watershed area associated with this tributary is estimated to be only about 125 acres in size and includes about 2,500 feet of existing I-93 roadway. Its watershed contains a fair amount of residential development along Morrison Road, North Lowell Road and County Road.

During the 2002-2003 sampling study, this stream was only sampled downstream of the I-93 roadway because of the lack of discernable stream channel upstream. The average specific conductance level and chloride concentration was 347 µs/cm and 77 mg/l, respectively, which are very similar to the results for the north tributary to Golden Brook, discussed above. There appears to be very little impact on these streams associated with the use of road salt on the I-93 roadway. Interestingly enough, this stream has a smaller watershed area and about the same amount of I-93 roadway area in its watershed as the north tributary to Canobie Lake and yet this stream had less than half the average specific conductance level and chloride concentration as the latter stream (NHDOT 2003). Again, this points to the significance of another chloride source in the north tributary to Canobie Lake.

North Tributary to Flatrock Brook

This headwater stream to Flatrock Brook originates just east and north of the Windham Depot area. There appear to be two branches with one branch originating approximately 100 feet east of the I-93 roadway and another that begins north of the Windham Depot area. The two branches join and then flow in an easterly direction crosses beneath North Lowell Road and along the base of the abandoned Boston and Maine railroad bed and then joins Flatrock Brook just below Mitchell Pond. The watershed area of this tributary is estimated to be about 350 acres upstream of its crossing with the abandoned rail bed. This stream was not sampled as part of the 2002-2003 sampling study.

South Tributary to Beaver Brook

This unnamed tributary to Beaver Brook originates just west of I-93, in the northern portions of the Town of Windham and crosses beneath I-93 about a 0.5 mile north of the Windham/Derry town boundary. This stream flows in a northeasterly direction and empties into the Beaver Brook on the east side of I-93 near the downtown village of West Derry and near Exit 4. This stream traverses through a large portion of the stratified-drift aquifer that is associated with Beaver Brook and, therefore, is likely to be supported in large part by groundwater discharge from the surrounding sand and gravel deposits. It has an estimated watershed area of about 1150 acres, upstream of I-93, and appears to flow through a large wetland complex located just east of I-93.

This stream was sampled both upstream and downstream of the existing I-93 roadway during the 2002-2003 sampling study. The average upstream and downstream specific conductance levels were 343 and 418 µs/cm, respectively, which is roughly a 22 percent difference. The average upstream and downstream chloride concentrations were 88 and 97 mg/l, respectively, which is roughly a 10 percent difference. Road salt applications on the I-93 roadway appear to have a limited effect on this stream (NHDOT 2003).

North Tributary to Beaver Brook

Another smaller unnamed tributary to Beaver Brook forms just south of the actual Beaver Brook/I-93 crossing. This stream flows in a westerly direction, opposite of the southern tributary, and flows parallel to and eventually into Beaver Brook about 2.0 miles west of I-93. Its watershed area, upstream of I-93, is estimated to be only about 145 acres.

During the 2002-2003 sampling study, this stream was sampled downstream of the I-93 roadway, again, due to the lack of a discernable channel upstream. The average specific conductance level and chloride concentration were 266 µs/cm and 55 mg/l, respectively. These values were lower than those recorded in the reference stream, namely the Searles Road tributary , as previously discussed (NHDOT 2003).

Beaver Brook

Beaver Brook represents the second largest stream in the project area behind Spicket River. Beaver Brook flows in a southeasterly direction with much of its watershed located within the Town of Derry and includes a large upstream impoundment called Beaver Lake, a highly regarded recreation source in the area. The brook is crossed by I-93 essentially right at the Derry/Londonderry town boundary. The former Derry Municipal Solid Waste Landfill, which is now closed and capped, and the Derry Wastewater Treatment Facility are located just east or upstream of I-93. A large stratified sand and gravel deposit is located within the Beaver Brook corridor. Its upstream watershed is estimated to be span over 25 square miles or more than 15,000 acres. About 4.0 miles downstream at a US Geological Survey gauging station located near the intersection of Routes 111 and 128 in West Windham, the Beaver Brook watershed is estimated to increase to about 41 square miles in size.

During the 2002-2003 sampling study, this stream was sampled both upstream and downstream of the I-93 roadway. The average upstream and downstream specific conductance levels were 360 and 371 µs/cm, respectively, which represents about a 3 percent difference. The average upstream and downstream chloride concentrations were 98 and 99 mg/l, respectively, which represents about a 1 percent difference. The data indicates that upstream levels are already slightly elevated and there is limited effect from the I-93 roadway (NHDOT 2003). The preliminary monitoring results for the 2003-2004 winter season indicate a 10 percent difference between average specific conductance levels of 394 and 433 µs/cm measured upstream and downstream of the I-93 roadway, respectively. The preliminary peak 4-day average levels were recorded to be 896 and 927

µs/cm for the upstream and downstream stations, respectively. Additional data will be collected through mid-April 2004.

Tributary to Wheeler Pond

North of Exit 4, another tributary stream originates to the west side of I-93 and flows parallel to and within 100 feet of the southbound lanes for about 0.75 mile and then crosses beneath I-93, near the Pillsbury Road overpass and eventually empties into Wheeler Pond located next to the northbound on-ramp at Exit 4. Wheeler Pond is less than 10 acres and is not listed on the state's official list of public water bodies in accordance with RSA 271:20.II. However, it is still considered to be surface waters of the state. Much of the immediate area around the pond consists of impervious area associated with commercial businesses and their parking lots. The outlet to Wheeler Pond crosses beneath NH Route 102 within the study area and eventually makes its way to Beaver Brook through a series of culverts located in West Derry. The upstream watershed area for this tributary, above I-93, is estimated to be about 550 acres.

During the 2002-2003 sampling study, this stream was sampled both upstream and downstream of the I-93 roadway. The average specific upstream and downstream conductance levels were 431 and 555 µs/cm, respectively. The average upstream and downstream chloride concentrations were 107 and 133 mg/l, respectively, which represents a 25 percent increase (NHDOT 2003).

Tributary to Hoods Pond - near Stonehenge Road

This small tributary stream originates in a large wetland just west of I-93, in between Exits 4 and 5 and near the Stonehenge Road overpass. It flows easterly beneath I-93 and then southerly for about 2.0 miles, where it flows into Hoods Pond. Hoods Pond is a small pond of about 2 to 3 acres in size located in the heavily developed area just north of the West Derry downtown area. The upstream watershed, above I-93, is estimated to be about 320 acres in size.

This stream was sampled both upstream and downstream of the I-93 roadway. The average upstream and downstream specific conductance levels were 264 and 318 µs/cm, respectively, which is about a 20 percent difference. The average upstream and downstream chloride concentrations were 61 and 71 mg/l, respectively, which is about a 17 percent difference. Again, this data is about the same as the data recorded in the reference stream, namely the Searles Road tributary (NHDOT 2003).

Tributary to Little Cohas Brook

The tributary to Little Cohas Brook originates about 2,000 feet to the west of I-93 in North Londonderry and just south of Exit 5. The stream flows northerly crossing beneath NH 28 about 1,000 feet west of the Exit 5 Interchange, but is not crossed by the I-93 roadway. Its watershed area above the crossing with NH 28 is estimated to be about 520 acres and includes about 4,000 feet of the existing I-93 roadway south of Exit 5 and most of the Exit 5 Interchange area.

During the 2002-2003 sampling study, this stream was sampled upstream and downstream of Route 28 just west of the Exit 5 Interchange. The average upstream and downstream specific conductance levels were 195 and 297 µs/cm, respectively, which is about a 52 percent difference. The average upstream and downstream chloride concentrations were 38 and 85 mg/l, respectively, which is about a 123 percent difference. This relatively large difference between the two averages is primarily due to the results from two events in February. The downstream concentrations on February 4th and 19th were measured at 280 and 230 mg/l compared to 39 and 37 mg/l upstream. It was noted that during the February events, the plowed-up snow banks from the adjacent parking lot were pushed into and along the edge of the stream banks near the downstream sampling location. During the other events when there was limited or no new snow banks, the difference between the upstream and downstream chloride concentration was usually less 3.0 mg/l or less than 10 percent. Thus, the plowed snow banks from the adjacent parking lot appear to be the primary cause for the elevated downstream concentrations (NHDOT 2003).

Cohas Brook

Cohas Brook is the third largest stream in the study area and originates from several headwater streams located in northeast Londonderry and the western portions of Auburn. Much of its watershed area is comprised of sand and gravel deposits, which contribute groundwater discharge and help to sustain base flow in the headwater streams. Most of the I-93 roadway, north of Exit 5, is within the Cohas Brook watershed. A small section of the southbound lanes drains to Crystal lake first and then eventually into Cohas Brook. The brook flows west and north crossing beneath the northbound lanes of I-93 about 0.5.mile north of the Londonderry/Manchester city line. It then flows north within the median of I-93 for nearly 1.0 mile and receives flow from Long Pond Brook, before crossing a back underneath the northbound lanes and continuing north before joining the outlet stream of Massabesic Lake. It then flows west crossing through the interchange area of I-93 and I-293 and further west around the Manchester Airport and eventually into the Merrimack River. Its watershed area, upstream of the point where it crosses the I-93/I-293 interchange, is estimated to be about 5,000 acres.

During the 2002-2003 sampling study, this stream was sampled upstream and downstream of the I-93 roadway. The average upstream and downstream specific conductance levels were 189 and 355 µs/cm, respectively. The average upstream and downstream chloride concentrations were 40 and 66 mg/l, respectively, which is about a 65 percent difference. Although the percent difference is relatively large (third highest of all streams), the downstream chloride concentrations for each event were generally below 60 to 80 mg/l and similar to that observed in the Searles Road tributary, the reference stream, except during one event. During the December 13th, 2002 event, the downstream chloride concentration was measured at 190 mg/l, which was more than twice as high as any other event. In general, the highest concentrations of the season were observed for many streams on this event. According to the NHDOT District 5 Engineer, in the early morning hours of December 13th, there was steady precipitation followed by a

rapid drop in air temperatures which resulted in reports of "black ice" conditions developing in many locations. As a result, perhaps heavier and/ or more frequent road salt applications were made to quickly de-ice and prevent further "black ice" development. These applications occurred just hours before sampling and may have led to higher chloride concentrations in some streams.

Long Pond Brook

Long Pond Brook is a small tributary stream to Cohas Brook that originates as the outlet out of Long Pond located about 3,500 feet east of I-93 and near Lake Massabesic. The Pond itself is about 2,500 feet long by about 400 feet wide. The entire watershed of the Brook is estimated to be about 370 acres, of which, nearly 95 percent is upstream of the I-93 roadway. Only the last 100 feet or so of the Brook enters the project area as it flows beneath the northbound lanes and joins Cohas Brook within the median area. This stream was not sampled as part of the 2002-2003 sampling study.

Tributary to Cohas Brook

The tributary to Cohas Brook is another small stream located at the very northern end of the project area. The stream originates about 1.0 mile north of the project area along the I-93 northbound lanes and flows south within 100 feet of the northbound lanes and empties into the Cohas Brook just as Cohas Brook turns westward and flows through the I-93/I-293 Interchange area. The watershed to this stream is estimated to be only about 120 acres. This stream was not sampled as part of the 2002-2003 sampling study.

Summary

In general, the water quality data collected in the 2002-2003 sampling study revealed that few streams appear to consistently have much higher chloride concentrations downstream relative to upstream concentrations. In the 10 streams sampled both upstream and downstream of the I-93 roadway, seven had less than a 31 percent increase in the average downstream chloride concentration compared to the average upstream chloride concentration. Five streams had less than a 20 percent difference between the average upstream and downstream chloride concentration. The three streams that had substantially larger differences include the south tributary to Canobie Lake, Cohas Brook and Dinsmore Brook. Dinsmore Brook was the only stream that had downstream chloride concentrations that were frequently above 100 mg/l. Downstream chloride concentrations for the other two streams generally ranged between 60 and 80 mg/l and were similar to the Searles Road tributary, the reference stream. The additional specific conductance data collected by NHDES in 2002-2003 indicate that levels in Policy Brook exceed 850 µs/cm during most of February and for one short-term period in December within Policy Brook.

The two streams that consistently had the highest chloride concentrations were Policy Brook and the north tributary to Canobie Lake. As discussed earlier, the elevated chloride concentrations observed in the north tributary to Canobie Lake are most likely due in part to the water softening treatment system discharge from a nearby community

well. For Policy Brook, the upstream chloride concentrations were also elevated and, on average, the downstream concentrations were only 14 percent higher than the upstream concentrations. Additional data collected in the 2003-2004 season confirmed that specific conductance levels in Policy Brook were elevated upstream particularly in the north tributary to Policy Brook, which had an average specific conductance level of 1,200 µs/ms through March 2004. Little Cohas Brook also had elevated chloride concentrations during two events, which appear to be related to plowed-up snow from a parking lot.

Overall, the water quality data collected to date, both in the 2002-2003 and 2003-2004 winter seasons indicate that chloride concentrations may, on occasion during the winter months, exceed the chronic water quality criteria in the Spicket River, Policy Brook, tributary to Harris Brook, north tributary to Canobie Lake, Dinsmore Brook, Beaver Brook and Little Cohas Brook. Aside from Dinsmore Brook, these elevated concentrations appear to be influenced more by other upstream sources as opposed to the I-93 roadway. These other sources include the salts used in water softening treatment systems and the road salt used and stored in open piles on commercial parking lots as well as that applied to municipal roadways.

3.4.1.4 Aquatic Life

The biotic communities found in the lakes, ponds, and streams within the study area contain a wide variety invertebrates, fish, amphibians, reptiles, aquatic mammals and birds, and aquatic plants. Complete lists of wildlife species commonly found in these habitats, including adjacent riparian areas, are provided in Appendix D. Numerous State of New Hampshire laws protect these aquatic resources by protecting the water quality of lakes and streams. The New Hampshire Department of Environmental Services (NHDES) is responsible under (RSA 21-0:1) for control of water pollution, protection of water supplies, regulation of waste disposal that may affect water quality, and regulation of dams.

Many bird species use open-water habitats for various life history requirements. Waterfowl, primarily surface feeding ducks like mallards (*Anas platrhynchos*) and black ducks (*Anas rubripes*), are commonly observed on Canobie Lake and Cobbetts Pond as well as on the larger streams like the Spicket River, Beaver Brook, and Cohas Brook. Wood ducks (*Aix sponsa*) are also common on lakes and ponds with woodland edges and along wooded streams. Canada geese (*Branta canadensis*) are frequently observed on the lakes and ponds feeding on submerged aquatics and macroinvertebrates, or on nearby fields and lawns where they feed on grasses and other succulent herbs. Belted kingfishers (*Megaceryle akcyon*) are commonly seen feeding in all of the open-water habitats, while several species of swallow, including barn (*Hirundo rustica*), bank (*Riparia riparia*), and tree (*Iridoprocne bicolor*) are aerial feeders over these habitats. Typical aquatic mammals in these habitats include beavers (*Castor canadensis*), muskrats (*Ondatra zibethicus*) and river otters (*Lutra canadensis*). All migratory bird species are protected by Federal law, while most birds and mammals are also afforded some level of protection under various state laws.

Game fish are managed by the State of New Hampshire Fish and Game Department (NHF&GD) and their harvest is regulated by State legislation. The State of New Hampshire has also adopted fishing regulations which include the quantity and allowable size of fish that can be kept, the time and season during which fishing for these species can occur and licensing procedures.

Waterbodies in the study area support several coldwater species (salmonids) and a variety of warmwater species including yellow perch, (*Perca flavescens)*, white perch, (*Morone americana)*, smallmouth bass, (*Micropterus dolomieu*), largemouth bass, (*Micropterus salmoides)*, and pickerel (*Esox niger*). The NHF&GD has been augmenting native and introduced species of fish populations for several decades and compiles yearly fish stocking records and water quality related information for lakes, streams and ponds within the State. Stocked waterbodies within the study area include the Spicket River, Canobie Lake, Beaver Brook, and Little Cohas Brook. With the exception of Beaver Brook, currently stocked with rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*), the Spicket River, Canobie Lake and Little Cohas Brook are stocked only with brook trout (D. Walsh 2002; NHF&GD, pers. comm.). Brook trout are the predominant sportfish in Hillsboro and Rockingham Counties, and can be found in lakes and streams throughout the entire study area.

The Spicket River, Policy Brook, Porcupine Brook, Beaver Brook, Little Cohas Brook and Cohas Brook are the major waterways in the study area, and support fish species including brook trout, brown trout and rainbow trout. These waterways are generally low-gradient, meandering point-bar, riffle-pool alluvial channels with broad, well-defined floodplains. In addition to these six major waterways, 15 additional perennial and 58 intermittent watercourses are located within the study area. The majority of these waterways are characterized as low-gradient, slightly entrenched waterways with moderately embedded substrates. Embeddedness refers to the degree that larger particles, including cobble and gravel, are covered or surrounded by fine sediment. In the vicinity of the study area, most waterways exhibited varying levels of embeddedness. Roadway sand and untreated stormwater entering these waterways has impacted the viability of aquatic ecosystem functions and processes by degrading habitat for invertebrates, fish and amphibians.

Principal lakes in the study area include Canobie Lake, Cobbetts Pond and Crystal Lake. Section 3.4.1.2 describes the exiting water quality conditions in each of these lakes. In general, these lakes are considered to be relatively shallow (i.e., less than 30 to 40 feet deep) for much of their surface area with some deeper spots of up 60 to 80 feet. These lakes are also considered to have low to moderate amounts of algal productivity and little to no dissolved oxygen at depth for much of the summer months. Due to their algal productivity, warm water temperatures and other physical and chemical parameters these waterbodies primarily support only warmwater fish species.

Electro-shocking and net survey efforts conducted concurrently with previous limnological studies indicated that the following species were present in Canobie Lake: smallmouth bass, largemouth bass, eastern chain pickerel, rainbow trout, yellow perch, white perch, brown

bullhead (*Ameiurus nebulosus*), golden shiner (*Notemigonus crysoleucas*), common sunfish (*Lepomis* sp.), black crappie (*Pomoxis nigromaculatus*), pumpkinseed sunfish (*Lepomis gibbosus*) and American eel (*Anguilla rostrata*). Cobbetts Pond contained eastern chain pickerel, yellow perch, brown bullhead, pumpkinseed sunfish and alewives (*Alosa pseudoharengus*). Numerous smaller ponds and streams scattered throughout the study area provide suitable habitat for one or more of these fish species.

The physical characteristics of the stream crossings, at both bridges and culverts, are summarized in Table 3.4-2. Refer to **Figure 3.4-1** for locations of these stream crossings.

3.4.1.5 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) established a requirement to describe and identify "essential fish habitat" (EFH) in each federal fishery management plan. EFH is defined as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." "Waters" include aquatic areas and their associated physical, chemical and biological properties.

Fishery Management Councils determine which areas will be designated as EFH. The New England Council has determined that the Merrimack River and tributaries to the Merrimack River are EFH for Atlantic salmon (*Salmo salar*). The MSA requires all federal agencies to consult with the National Marine Fisheries Service (NMFS) on all proposed federal actions that may adversely affect EFH.

Designated EFH in the study area includes Cohas Brook and Little Cohas Brook (P. Colosi, Jr., NMFS, letter dated April 13, 2004). NMFS concerns for this project relative to EFH include both direct impacts to the stream itself or its banks and any indirect impacts on water quality due to stormwater runoff and associated erosion and sedimentation during construction activities.

3.4.1.6 Wild, Scenic, or NH Designated Rivers

There are no rivers, brooks, or streams in the study area either under study or currently listed with the National Wild and Scenic Rivers Program. None of the rivers, brooks or streams in the study area are under study either for protection, or are currently designated, as natural, rural, or community rivers under the New Hampshire Rivers Management and Protection Program under RSA Chapter 483.

3.4.1.7 Navigation

There are no navigable waters in the study area. There are no rivers or waterbodies susceptible to use in its natural condition or by reasonable improvement as a means to transport interstate or foreign commerce. Thus, under the provisions of the Surface Transportation and Uniform Relocation Assistance Act of 1987, the project does not require a U.S. Coast Guard permit.

Table 3.4-2
Stream Crossings – Bridges and Culverts

Segment	Watercourse Name/Type	Watershed	Fish Habitat	Northbound ID#	Southbound ID#	Connectivity[1]	Perennial/ Intermittent	Average Width (feet)		Average Depth (inches)		Dominant Substrate	Average Flow[2] (CFS)	Culvert Diameter (Inches)	Crossing Type[3]	Comments
								East of I-93	West of I-93	East of I-93	West of I-93					
A	**Tributary to Harris Brook**	Spicket River	yes	-	77S	No	perennial	-	10	-	12	sand, gravel	< 0.5	24	RCP	North portion is drainage swale, southern portion may support warmwater species
B	Drainage swale[4]	Spicket River	no	77A	-	No	intermittent	n/a	-	n/a	-		n/a	18	CMP	Conveys stormwater only
	Policy Brook	Spicket River	yes	77B	-	No	perennial	11	-	12	-	cobble, gravel	10	120	CMP	May supports warmwater species
	Drainage swale	Spicket River	no	77C	-	No	intermittent	n/a	-	n/a	-	n/a	n/a	24	RCP	Conveys stormwater only
	Drainage swale	Spicket River	no	-	76S	No	intermittent	-	n/a	-	n/a	sand	n/a			No defined channel, stormwater only
	Tributary to Porcupine Brook	Spicket River	yes	75N	75S	Yes	perennial	1	10	18	9	sand, gravel	3	36	RCP	Channel slightly downcut, may support warmwater species, some exposed gravels
	Intermittent watercourse	Spicket River	no		74S	No	intermittent	-	7	-	8	sand	0-standing water	18	RCP	Excavated channel conveying stormwater only
	Drainage swale	Spicket River	no	74A	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	18	RCP	Conveys stormwater only
C	Drainage swale	Spicket River	no	73N	73S	yes	intermittent	1.3	2	1	n/a	vegetated	0-standing water	24	RCP	Excavated channel conveying stormwater only
	Drainage swale	Spicket River	no	-	72S	no	intermittent	-	2	-	6	sand	< 0.1	18	CMP	Severely degraded excavated channel
	Drainage swale	Spicket River	no	-	71S	no	intermittent	-	1.7	-	5	silt, sand	< 0.1	24	RCP	Conveys stormwater only
	Porcupine Brook	Spicket River	yes	70N	70S	yes	perennial	12	15	20	18	cobble, gravel	9	120	bridge	Cobble/subangular gravel substrate provides spawning habitat
	Drainage swale	Spicket River	no	-	69S	no	intermittent	-	n/a	-	n/a	n/a	n/a	24	RCP	Conveys stormwater only
	Tributary to Porcupine Brook	Spicket River	no	68N	68S	yes	perennial	10	4	7	6	sand	2	60	RCP	Short section of degraded channel; two unidentified fish observed
	Drainage swale	Spicket River	no	-	67S	no	intermittent	-	3	-	5	sand	< 0.1	24 and 36	RCP	Significantly embedded channel
	Tributary to Porcupine Brook	Spicket River	yes	-	66S	no	perennial	-	3	-	8	sand, gravel	1.0	48	RCP	Unidentified fish observed in portion of channel south of Main street
	Drainage swale	Spicket River	no	66A	-	no	intermittent	3	-	1	-	sand, gravel	< 0.1	18	RCP	Outflow from small impoundment
	Drainage swale	Spicket River	no	66B	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	12	RCP	Seep and drainage swale contribute hydrology
	Drainage swale	Spicket River	no	66C	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	unknown (buried)	RCP	Conveys stormwater only
	Drainage swale	Spicket River	no	66D	-	no	perennial	7	-	10	-	boulder, cobble	1.0	60	RCP	Perennial outflow from PFO and unnamed pond
	Drainage swale	Spicket River	no	66E	-	no	intermittent	6	-	3	-	sand, gravel	< 0.2	24	RCP	Portion of tributary to Porcupine Brook
	Drainage swale	Spicket River	no	-	65S	no	intermittent	-	1.5	-	4	sand, subangular gravel	0.3	24	RCP	Conveys stormwater only, reduced iron in channel
	Drainage swale	Spicket River	no	-	64S	no	intermittent	-	n/a	-	n/a	n/a	n/a	12	RCP	No flow or defined channel, conveys stormwater only
	Drainage swale	Spicket River	no	-	63S	no	intermittent	-	n/a	-	n/a	n/a	n/a	12	CMP	No flow or defined channel, conveys stormwater only
	Intermittent watercourse	Spicket River	no	-	62S	no	intermittent	-	> 5	-	8	cobble, gravel	2.0	24	RCP	Part of 61, conveys stormwater only
	Drainage swale	Spicket River	no	61N	61S	yes	intermittent	-	4	-	7	cobble, gravel	0.75	24	RCP	Tributary to Policy Brook, step-pool system
	Drainage swale	Spicket River	no	61A	-	no	intermittent	3	-	5	-	cobble, gravel	< 0.2	12 and 24	RCP	Stormwater from median strip, eastern edge of NB lane
	Intermittent watercourse	Spicket River	no	60N	60S	yes	intermittent	3	-	3	-	sand, gravel	< 0.1	24	RCP	Tributary to Canobie Lake, also drains median strip
D	Intermittent watercourse	Spicket River	no	59N	59S	yes	intermittent	1.5	-	5	-	cobble, small boulder	< 0.2	24	RCP	Conveys stormwater from upgradient swales
	South Tributary to Canobie Lake	Spicket River	yes	58N	58S	yes	perennial	4	3	5	7	cobble, sand	1.5	48	RCP	May provide fish habitat, production export; Canobie Lake stocked with eastern brook trout (*Salvelinus fontinalis*)
	Intermittent watercourse	Spicket River	no	57A	-	no	intermittent	4	-	3	-	cobble, gravel	0.3	14	RCP	Conveys stormwater from drainage swales
	Intermittent watercourse	Spicket River	no	-	57S	no	intermittent	-	n/a	-	n/a	n/a	0-standing water	18	RCP	No channel, depressional wetland
	North Tributary to Canobie Lake	Spicket River	no	56N	56S	yes	perennial	-	1.5	-	5	sand, gravel	< 0.1	12	CMP	Conveys stormwater and overland flow; Canobie Lake stocked with eastern brook trout (*Salvelinus fontinalis*)
	Intermittent watercourse	Golden Brook	no	-	55S	no	intermittent	-	3	-	8	silt, sand	0.5	12?	RCP	Buried with sediment to culvert bell
	Drainage swale	Golden Brook	no	55A	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	12	RCP	Conveys stormwater only, no defined channel
	Intermittent watercourse	Golden Brook	no	55B	-	No	intermittent	n/a	-	n/a	-	n/a	n/a	30	RCP	Channel undefined, diffuse flow in wetland

1 Connectivity denotes a continuous east-west culvert connection under the northbound and southbound lanes.
2 Channel flow was estimated in cubic feet per second (CFS) by determining the cross section (average width x average depth) of the watercourse and estimating the city in feet per second (FPS).
3 Crossing type abbreviations: reinforced concrete pipe (RCP), corrugated metal pipe (CMP) and bridge (also referred to as a box culvert). SCH 40 denotes schedule 40 extruded polyvinyl chloride piping.
4 Drainage swale denotes an area with no defined channel; typically a maintained, grass-lined swale. Some swales, or portions of, have been stabilized with riprap, cobble, gravel, concrete, or small boulders.

Table 3.4-2 (continued)

Segment	Watercourse Name/Type	Watershed	Fish Habitat	Northbound ID#	Southbound ID#	Connectivity[1]	Perennial/ Intermittent	Average Width (feet) East of I-93	Average Width (feet) West of I-93	Average Depth (inches) East of I-93	Average Depth (inches) West of I-93	Dominant Substrate	Average Flow[2] (CFS)	Culvert Diameter (Inches)	Crossing Type[3]	Comments
D Cont'd	**Tributary to Cobbetts Pond**	Golden Brook	yes	55C	-	no	perennial	4	-	8	-	sand, gravel	1.5	48	RCP	Heavily embedded channel; portions may support small warmwater fishery
	Intermittent watercourse	Golden Brook	no	-	54S	no	intermittent	-	2	-	5	sand, gravel	< 0.1	18	RCP	Conveys stormwater only, excavated channel
	Drainage swale	Golden Brook	no	-	53S	no	intermittent	-	n/a	-	n/a	n/a	n/a	18	CMP	Conveys stormwater only, no defined channel
	Intermittent watercourse	Golden Brook	no	-	52S	no	intermittent	-	4	-	10	cobble, small boulder	1.5	24	RCP	High-gradient step-pool watercourse
	Intermittent watercourse	Golden Brook	no	52N	-	no	intermittent	1.8	-	2	-	sand, gravel	2.0	36	RCP	Step-pool watercourse, possible fish habitat
	Drainage swale	Golden Brook	no	-	52A	no	intermittent	-	n/a	-	n/a	n/a	n/a	18	RCP	Vegetated swale with no defined channel conveying stormwater
	Drainage swale	Golden Brook	no	-	52B	no	intermittent	-	n/a	-	n/a	n/a	n/a	24	RCP	Conveys stormwater via swales, no defined channel
	Drainage swale	Golden Brook	no	-	52C	no	intermittent	-	n/a	-	n/a	n/a	n/a	12 and 18	RCP and PVC	Riprap depressional area conveying stormwater and overland flow
	Drainage swale	Golden Brook	no	-	52D	no	intermittent	-	n/a	-	n/a	n/a	n/a	18	RCP	Riprap swale conveys overland flow from upgradient areas
	INTERMITTENT watercourse	Golden Brook	no	-	52E	no	intermittent	-	3.3	-	7	sand, gravel	2.0	n/a	n/a	No culvert crossings along proposed alignment
	Intermittent watercourse	Golden Brook	no	-	52F	no	intermittent	-	n/a	-	1	silt, sand	< 0.1	24	RCP	No defined channel, diffuse flow through PEM
	Intermittent watercourse	Golden Brook	no	-	52G	no	intermittent	-	n/a	-	n/a	n/a	n/a	18	RCP	Conveys stormwater from grass swales
	Intermittent watercourse	Golden Brook	no	-	52H	no	intermittent	-	n/a	-	n/a	unknown	n/a	18	RCP	Conveys stormwater and flow from small isolated wetlands north of Route 111
	Intermittent watercourse	Golden Brook	no	-	52I	no	intermittent	-	3	15	-	unknown	0-standing water	Unknown (submerged)	unknown	Submerged culvert conveying flow from small isolated POW
	Tributary to Cobbetts Pond	Golden Brook	no	51N	51S	yes	perennial	1.3	-	4	-	n/a	0.3	24 and 6	RCP and PVC	Step-pool watercourse with undercut banks
	Intermittent watercourse	Golden Brook	no	-	50S	no	intermittent	-	2	-	5	sand, gravel	0.3	24	RCP	High gradient step-pool watercourse
	Intermittent watercourse	Golden Brook	no	-	49S	no	intermittent	-	n/a	-	n/a	n/a	n/a	24	RCP	No defined channel, conveys stormwater only
	South Tributary to Golden Brook	Golden Brook	yes	-	48S	no	perennial	-	3	-	12	sand, gravel	1.0	60	RCP	Part of south tributary to Golden Brook
	Intermittent watercourse	Golden Brook	no	47A	-	no	intermittent	n/a	-	n/a	-	sand	0-standing water	18	RCP	No defined channel, drains PFO and swales
	South Tributary to Golden Brook	Golden Brook	no	47N	47S	yes	perennial	1.5	-	5	-	n/a	< 0.2	48	RCP	Receives flow from PFO, drainage swales and weigh station impervious surface areas
	Intermittent watercourse	Golden Brook	no	-	46S	no	intermittent	-	n/a	-	n/a	n/a	n/a	24	RCP	Conveys stormwater from drainage swales
	Intermittent watercourse	Golden Brook	no	-	45S	no	intermittent	-	n/a	-	n/a	n/a	n/a	12	RCP	Conveys stormwater to downgradient catch basin
	Intermittent watercourse	Golden Brook	no	45A	-	no	intermittent	1.2	-	2	-	n/a	< 0.1	24 and 36	RCP	Conveying flow from swales and PFO
	Intermittent watercourse	Golden Brook	no	45B	-	no	intermittent	3	-	5	-	n/a	< 0.1	24 and 36	RCP	Draining upgradient PFO and conveying stormwater
	Intermittent watercourse	Golden Brook	no	45C	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	24	RCP	Drains upgradient seep and drainage swales
	North Tributary to Golden Brook	Golden Brook	no	-	44S	no	perennial	-	1.7	-	14	riprap	< 0.2	18	RCP	Drains PFO, and convey stormwater from upgradient swales
	Intermittent watercourse	Golden Brook	no	-	43S	no	intermittent	-	2	-	4	sand, gravel	< 0.2	18	CMP	Convey stormwater to downgradient PFO
	Intermittent watercourse	Golden Brook	no	43A	-	no	intermittent	n/a	-	n/a	-		n/a	24, 6	RCP, CMP	Conveys stormwater from drainage swales
	South Tributary to Flatrock Brook	Golden Brook	yes	42N	42S	yes	perennial	6	-	5	-	cobble, gravel	1.0	36	RCP	Culverted under highway to 42, outflow to dead wood swamp; fish habitat observed
	North Tributary to Flatrock Brook	Spicket River	no	41N	41S	yes	perennial	4	2	4	7	sand, gravel	0.4	24	RCP	Outflow from large PFO, may support warm water fish species
E	Intermittent watercourse	Spicket River	no	40N	40S	yes	intermittent	0.8	n/a	1	n/a	n/a	< 0.1	24	RCP	Conveys stormwater from median swales and drains upgradient PFO, no defined channel southbound
	Intermittent watercourse	Spicket River	no	39N	39S	yes	intermittent	3	1.2	4	3	sand, gravel	< 0.3	24	RCP	Step-pool channel draining upgradient PFO and conveying drainage swale stormwater
	Intermittent watercourse	Spicket River	no	38N	38S	yes	intermittent	2	2	3	3	cobble, gravel	0.2	24	RCP	Receives flow from upgradient seep wetland, and drainage swales
	South Tributary to Beaver Brook	Beaver Brook	yes	37N	37S	yes	perennial	10	>10	13	>24	sand, gravel	2.0	60	RCP	Conveying drainage from POW east to PEM; fish habitat in some reaches
	Drainage swale	Beaver Brook	no	37A	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	18	CMP	Conveys stormwater from upgradient catch basins; no defined channel
	Intermittent watercourse	Beaver Brook	no	37B	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	24	RCP	Conveys stormwater from drainage swales to PEM
	Drainage swale	Beaver Brook	no	-	36S	no	intermittent	-	n/a	-	n/a	n/a	n/a	24	RCP	Conveys stormwater from swales; no defined channel
	Intermittent watercourse	Beaver Brook	no	-	35S	no	intermittent	-	1.5	-	2	cobble, gravel	< 0.2	18	CMP	Narrow downcut channel with step-pool morphology
	Intermittent watercourse	Beaver Brook	no	34A	-	no	intermittent	-	-	-	-	n/a	n/a	12	CMP	Conveys stormwater for drainage swales into downgradient PFO
	North Tributary to Beaver Brook	Beaver Brook	yes	34N	34S	yes	perennial	4	5	6	6	riprap	0.5	48	RCP	Outflow from PEM; marginal fish habitat; may support warmwater fishery
	Beaver Brook	Beaver Brook	yes	33N	33S	yes	perennial	25	25	24	24	sand, gravel	12	288 x 96	bridge	Fish habitat, otter activity observed, steep undercut banks
	Intermittent watercourse	Beaver Brook	yes	32N	32S	yes	intermittent	> 4	3	5	3	sand, silt	0.4	36	RCP	drains PEM in median and PFO west of SB lane; broad diffuse flow in median
	Drainage swale	Beaver Brook	no	32A	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	12	CMP	Conveying stormwater from drainage swales

1 Connectivity denotes a continuous east-west culvert connection under the northbound and southbound lanes.
2 Channel flow was estimated in cubic feet per second (CFS) by determining the cross section (average width x average depth) of the watercourse and estimating the velocity in feet per second (FPS).
3 Crossing type abbreviations: reinforced concrete pipe (RCP), corrugated metal pipe (CMP) and bridge (also referred to as a box culvert). SCH 40 denotes schedule 40 extruded polyvinyl chloride piping.
4 Drainage swale denotes an area with no defined channel; typically a maintained, grass-lined swale. Some swales, or portions of, have been stabilized with riprap, cobble, gravel, concrete, or small boulders.

Table 3.4-2 (continued)

Segment	Watercourse Name/Type	Watershed	Fish Habitat	Northbound ID#	Southbound ID#	Connectivity[1]	Perennial/ Intermittent	Average Width (feet)		Average Depth (inches)		Dominant Substrate	Average Flow[2] (CFS)	Culvert Diameter (Inches)	Crossing Type[3]	Comments
								East of I-93	West of I-93	East of I-93	West of I-93					
E Cont'd	**Tributary to Beaver Brook (outflow from Wheeler Pond)**	Beaver Brook	no	32B	-	no	perennial	5	-	7	-	cobble	2.5	48	RCP	Outflow from Wheeler Pond
	Drainage swale	Beaver Brook	no	32C	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	24	RCP	Conveying stormwater only; discharges to upland area
	Intermittent watercourse	Beaver Brook	no	-	31S	no	intermittent	-	2	-	7	sand	< 0.2	24	RCP	30' of channel between two culverts
	Intermittent watercourse	Beaver Brook	no	30N	30S	yes	intermittent	3	1.5	2	3	cobble, gravel	0.4	48	RCP	Drains upgradient PFO, outfall from excavated pond, conveys stormwater via off ramp swale
	Drainage swale	Beaver Brook	no	30A	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	14	RCP	Conveys stormwater from median drainage swale
	Drainage swale	Beaver Brook	no	30B	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	14	RCP	Conveys stormwater from median drainage swale
	Drainage swale	Beaver Brook	no	30C	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	14	RCP	Conveys stormwater from median drainage swale
	Drainage swale	Beaver Brook	no	29N	29S	yes	intermittent	n/a	n/a	n/a	n/a	n/a	n/a	24	RCP	Conveys stormwater from upgradient drainage swales; no defined channel
	Intermittent watercourse	Beaver Brook	no	28N	28S	yes	intermittent	5	3	8	4	silt, sand	< 0.25	12	RCP	Conveying stormwater from median drainage swales to downgradient strip of PSS/PFO
	Tributary to Wheeler Pond	Beaver Brook	yes	27N	27S	yes	perennial	6	4	7	8	cobble, gravel, sand	1.0	60	RCP	May support small fishery in south channel west of SB lane; receives stormwater via swales
	Tributary to Wheeler Pond	Beaver Brook	yes	26N	26S	yes	perennial	10	10	8	8	sand, organic , small cobble	0.5	24	RCP	Receives stormwater via median drainage swale; contributes to perennial watercourse along SB lane
	Intermittent watercourse	Beaver Brook	yes	25AN	25AS	yes	intermittent	4	4	4	4	cobble, gravel	0.5	18	RCP	Outflow from POW/PEM appears to cease flowing; reduced iron on substrate in median
	Intermittent watercourse	Beaver Brook	no	25N	25S	yes	intermittent	5	10	2	20	coarse sand	<0.1	36	RCP	Small scour pool at headwall; drains east PFO and drainage swale to west PFO
	Drainage swale	Beaver Brook	no	24N	24S	yes	intermittent	n/a	n/a	n/a	n/a	n/a	n/a	24, 6	RCP, CMP	No defined channel; convey stormwater via upgradient swales; drains to PFO
	Intermittent watercourse	Beaver Brook	no	-	23S	no	intermittent	-	9	-	15	sand, gravel	0-standing water	18	RCP	Turbid pool with reduced iron; receives stormwater via drainage swales
	Tributary to Wheeler Pond	Beaver Brook	no	22N	22S	yes	perennial	6	10	5	18	sand, gravel	0-standing water	18	RCP	Receives stormwater via drainage swales; drains large PFO
	Tributary to Wheeler Pond	Beaver Brook	no	21N	21S	yes	perennial	12	n/a	14	n/a	n/a	0-standing water	24	RCP	No channel or flow west side; drains to PFO; gw seepage?
	Drainage swale	Beaver Brook	no	-	20S	no	intermittent	-	n/a	-	n/a	n/a	n/a	24	RCP	No defined channel, conveys stormwater only
	Intermittent watercourse	Beaver Brook	no	20A	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	24	RCP	Conveys stormwater only; no defined channel
	Intermittent watercourse	Beaver Brook	no	20B	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	24	RCP	Conveys stormwater only; no defined channel
	Tributary to Hoods Pond	Beaver Brook	yes	19N	19S	yes	perennial	5	4	6	8	cobble, subangular gravel	1	60	RCP	Conveys stormwater from swales and overland flow; Hoods Pond stocked with eastern brook trout (*Salvelinus fontinalis*)
F	Intermittent watercourse	Beaver Brook	no	19AN	19AS	yes	intermittent	4	4	3	3	cobble, gravel	< 0.2	24	RCP	Draining upgradient PFO seep wetland; culverted through median; no exposed channel in median
	Intermittent watercourse	Beaver Brook	no	-	19B	no	intermittent	3	-	6	-	sand, gravel	< 0.2	18	CMP	Excavated channel contributing flow to PFO; receives flow via drainage swales and upgradient catch basins
	South Tributary to Cohas Brook	Beaver Brook	yes	18N	18S	yes	perennial	5	2	5	5	cobble, subangular gravel	0.25	24, 18	RCP	Outflow from small PFO; receives stormwater via drainage swales
	Intermittent watercourse	Little Cohas Brook	no	17N	17S	yes	intermittent	n/a	n/a	n/a	n/a	n/a	n/a	24	RCP	Conveying stormwater via upgradient swales and seep area at base of cut face
	Drainage swale	Little Cohas Brook	no	-	16S	no	intermittent	-	n/a	-	n/a	n/a	n/a	24	RCP	No defined channel, conveys stormwater only
	Tributary to Little Cohas Brook	Little Cohas Brook	yes	-	15S	no	perennial	-	3	-	6	cobble, gravel, sand	< 0.25	24	RCP	Drains upgradient PFO and receives overland flow from fill slope; slow disuse flow through emergent vegetation
	Tributary to Little Cohas Brook	Little Cohas Brook	Yes	14B New Park-and-Ride		n/a	perennial	4		12		Cobble, gravel, sand	2	18, 36	RCP, CMP	Flows northwest through wooded wetlands towards Symmes Drive.
	Drainage swale	Little Cohas Brook	no	15A	-	no	intermittent	6	-	4	-	cobble, gravel	< 0.1	18	RCP	Riprap swale filled with algae, reduced iron and manganese; receives stormwater and overland flow
	Drainage swale	Little Cohas Brook	no	-	14S	no	intermittent	-	n/a	-	n/a	n/a	0-standing water	24	RCP	Drainage swale with small areas of ponded water
	Drainage swale	Little Cohas Brook	no	-	13S	no	intermittent	-	n/a	-	n/a	n/a	n/a	24, 12	RCP, CMP	Conveys stormwater to upland grassy area
	Intermittent watercourse	Little Cohas Brook	no	-	12S	no	intermittent	-	4	-	2	sand, gravel	0-standing water	24	RCP	Conveys stormwater and drains upgradient PFO

1 Connectivity denotes a continuous east-west culvert connection under the northbound and southbound lanes.
2 Channel flow was estimated in cubic feet per second (CFS) by determining the cross section (average width x average depth) of the watercourse and estimating the velocity in feet per second (FPS).
3 Crossing type abbreviations: reinforced concrete pipe (RCP), corrugated metal pipe (CMP) and bridge (also referred to as a box culvert). SCH 40 denotes schedule 40 extruded polyvinyl chloride piping.
4 Drainage swale denotes an area with no defined channel; typically a maintained, grass-lined swale. Some swales, or portions of, have been stabilized with riprap, cobble, gravel, concrete, or small boulders.

Table 3.4-2 (continued)

Segment	Watercourse Name/Type	Watershed	Fish Habitat	Northbound ID#	Southbound ID#	Connectivity[1]	Perennial/ Intermittent	Average Width (feet)		Average Depth (inches)		Dominant Substrate	Average Flow[2] (CFS)	Culvert Diameter (Inches)	Crossing Type[3]	Comments
								East of I-93	West of I-93	East of I-93	West of I-93					
F Cont'd	**Tributary to Little Cohas Brook**	Little Cohas Brook	yes	11N	11S	yes	perennial	2	7	15	10	sand, silt, subangular gravel	1.5	36	RCP	Receives stormwater via swales and catch basins; west portion may support warm water fish species; Little Cohas Brook (in Londonderry) stocked with eastern brook trout (*Salvelinus fontinalis*)
	Drainage swale	Little Cohas Brook	no	-	10S	no	intermittent	-	n/a	-	n/a	sand	n/a	14	RCP	Conveys stormwater only, no defined channel, discharges to PEM
	Drainage swale	Little Cohas Brook		10A	-	no	intermittent	n/a	-	n/a	-	n/a	0-standing water	12	SCH 40 PVC	90 degree PVC elbow discharging to pool; no defined channel
	Intermittent watercourse	Cohas Brook	yes	9N	9S	yes	intermittent	10	2	12	6	sand, gravel	0.25	24	RCP	Conveys stormwater and drains seep; channel morphology not favorable for fish
	Drainage swale	Cohas Brook	no	-	8S	no	intermittent	-	n/a	-	n/a	cobble, boulder	n/a	24	RCP	Conveys stormwater only; no defined channel
	Drainage swale	Cohas Brook	no	8A	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	24	RCP	No defined channel; conveys stormwater only to adjacent PFO
	Drainage swale	Cohas Brook	no	8B	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	24, 6	RCP, CMP	No defined channel; conveys stormwater only to adjacent PFO
	Intermittent watercourse	Cohas Brook	yes	-	7S	no	intermittent	-	18	-	4	boulder, cobble, small gravel	< 0.25	36	RCP	Receives flow from slope PFO, step-pool morphology
	Intermittent watercourse	Cohas Brook	no	6N	6S	yes	intermittent	2	n/a	4	n/a	cobble, boulder, subangular gravel	0.5	36	RCP	No defined channel west of SB lane; conveys stormwater from drainage swales in median
	Intermittent watercourse	Cohas Brook	no	6B	-	no	intermittent	1.2	-	0.5	-	sand	< 0.1	24, 18	RCP, RCP	Conveys stormwater from upgradient drainage swales, drains to PFO; also receives flow from seep area
	Cohas Brook	Cohas Brook	yes	5A	-	yes	perennial	30	-	12	-	sand	25	372 x 144	bridge	Channel substrate predominantly dynamic, coarse sand, heavily embedded, no cover in channel for fish; Little Cohas Brook (in Londonderry) stocked with eastern brook trout (*Salvelinus fontinalis*)
	Intermittent watercourse	Cohas Brook	no	-	5S	no	intermittent	1.2	-	< 1.0	-	cobble, boulder	0- standing water	24	RCP	Receives flow from upgradient seep, slightly downcut channel, also conveys stormwater from upgradient drainage swales
	Intermittent watercourse	Cohas Brook	no	-	4S	no	intermittent	2.3	-	2	-	rounded and subangular gravel	< 0.5	40	RCP	Outflow from upgradient PFO; receives stormwater from riprap swale; well-entrenched channel
	Drainage swale	Cohas Brook	no	4A	-	no	intermittent	n/a	-	n/a	-	n/a	n/a	18	RCP	Conveys stormwater, no defined channel, area under construction
	Intermittent watercourse	Cohas Brook	no	4B	-	no	intermittent	n/a	-	8	-	sand	0- standing water	24	RCP	Outflow from PEM to Cohas Brook; debris partially blocking culvert; receiving large quantities of sand from upgradient construction areas
	Long Pond Brook	Cohas Brook	yes	4C	-	no	perennial	24	-	6	-	sand	0.4	60	RCP	Heavily aggraded channel; receiving large quantities of sand from upgradient construction areas
	Drainage swale	Cohas Brook	no	4D	-	no	intermittent	n/a	-	n/a	-	boulder, riprap	n/a	12 (2), 6	RCP (2), CMP	Riprap swale conveying stormwater from catch basins into Cohas Brook; newly constructed
	Cohas Brook	Cohas Brook	yes	4E	-	no	perennial	20	-	18	-	sand, coarse gravel	25	n/a	bridge	New piers from bridge, area completely altered, riprap slopes along channel, channel substrate heavily embedded, no cover or channel complexity
	Cohas Brook	Cohas Brook	no	3N	3S	yes	perennial	30	40	15	15	silt, sand, gravel	25	432 (36 feet)	bridge	Twin concrete box culverts. Heavily embedded substrate, receives stormwater via catch basins, banks reinforced with boulders, no channel complexity
	Intermittent watercourse	Cohas Brook	yes	-	2S	no	intermittent	-	5	-	8	coarse sand, gravel	1.5	24	RCP	Connects large PEM to Cohas Brook
	Intermittent watercourse	Cohas Brook	no	2A	-	no	intermittent	n/a	-	n/a	-		n/a no water	18	RCP	Drains median area into large PEM
	Drainage swale	Cohas Brook	no	-	1S	no	intermittent	-	3	8	-	silt, sand, riprap	0- standing water	30	RCP	Conveys stormwater from catch basing to Cohas Brook, outfall area significantly downcut
	North Tributary to Cohas Brook	Cohas Brook	yes	1A	-	yes	perennial	4	-	10	-	sand	0.5	n/a	n/a	Channel parallel to NB lane, tributary to Cohas Brook; fish observed under submerged vegetation

1 Connectivity denotes a continuous east-west culvert connection under the northbound and southbound lanes.
2 Channel flow was estimated in cubic feet per second (CFS) by determining the cross section (average width x average depth) of the watercourse and estimating the velocity in feet per second (FPS).
3 Crossing type abbreviations: reinforced concrete pipe (RCP), corrugated metal pipe (CMP) and bridge (also referred to as a box culvert). SCH 40 denotes schedule 40 extruded polyvinyl chloride piping.
4 Drainage swale denotes an area with no defined channel; typically a maintained, grass-lined swale. Some swales, or portions of, have been stabilized with riprap, cobble, gravel, concrete, or small boulders.

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3.4.2 Groundwater Resources

3.4.2.1 Stratified-Drift Aquifers

According to previous US Geological Survey (USGS) hydrogeologic investigations, there are two primary stratified drift aquifers located in the study area (Flanagan and Stekl, 1992). The two primary deposits are located at either end of the study area and are associated with the major river systems in the project area (**Figure 3.4-2**). Stratified-drift aquifers are typically composed of well-sorted sand and gravel material deposited by the melt waters of the late Pleistocene age glaciers when they retreated northward approximately 13,000 to 20,000 years ago. Depending on the overall size and depth of the deposits, the inherent porosity (i.e., void space) and permeability, these stratified-drift deposits can be highly productive aquifers for water supply purposes. Approximately 79 percent of the groundwater drawn from high capacity wells in the lower Merrimack and Coastal River basins is pumped from wells screened in stratified-drift aquifers (Stekl and Flanagan, 1992). The same US Geological Survey study estimated that approximately 24 percent of the southeastern New Hampshire region consisting of about 327 square miles, and includes the area south of Manchester and east of the Merrimack River from Londonderry to New Castle, is composed of stratified-drift deposits. The most productive stratified-drift aquifers are generally those that are composed of coarse-grained material lending to higher permeability values and have a saturated thickness or depth of more than 40 feet. These types of deposits typically have higher transmissivity values, which is a relative measure of the aquifer's capacity to transmit water and is based on permeability and the saturated thickness of the aquifer. Transmissivity values of more 2,000 square feet per day are generally needed to support large capacity wells.

The stratified-drift aquifer at the southern end of the study area extends from just south of the Massachusetts border northward to a point of just south of Exit 2 (**see Figure 3.4-2**). This aquifer generally follows the river valley associated with the Spicket River and extends throughout much of the watersheds of Harris Brook, Porcupine Brook and Policy Brook. Most of the southern stratified-drift aquifer area is considered to have relatively low transmissivity values of less than 1000 square feet per day because it is composed of fine-grained material and has shallow depths of less than 20 feet. There are several isolated areas within the aquifer that are considered to have medium transmissivity values of 1000 to 2000 square feet per day. One of these areas is a relatively small area that is located between the northbound Salem Rest Area and the Cross Street overpass and is traversed by the existing I-93 roadway. Another area is located west of I-93 and northwest of Exit 1, between Lowell Road and the Northeastern Glider Port. This area is composed of coarse grained material and has depths of 40 feet. The Town of Salem has two municipal wells located in this general area, referred to as the Turner and Donigan Wells. The Turner well is located about 3,000 feet due west of Exit 1 and south of Lowell Road.

The Donigan Well is located more to the north and about 3,000 west of Exit 2. Both of these wells are bedrock wells, according to NHDES data, and have not been used for more than a decade due to the detection of volatile organic compounds in the Turner Well and taste, odor and color problems in the Donigan Well. Thus, Salem's municipal water system is principally supplied by Canobie Lake.

Another larger section of the aquifer with medium transmissivity values is located to the east of the project area near the intersection of Rockingham Park Boulevard and NH 28. Much of the land area overlying this portion of the stratified-drift aquifer area is already developed with commercial properties and residential uses. This aquifer is not considered to be highly favorable for future wells given the known contamination problems and the extent of the existing development and related potential contamination sources within this aquifer area. Most of the residences and commercial properties throughout the project area are serviced by the Salem municipal water system.

The stratified-drift deposit located at the northern end of the project corridor covers a broad area associated with both the Beaver Brook and Cohas Brook watersheds. Again, the stratified deposits are generally located within the low-lying areas and along the river valleys and exclude the higher terrain areas that are generally composed of till deposits. Within the Beaver Brook watershed, narrow areas of stratified drift deposits generally follow the same course as the tributary to Wheeler Pond, the tributary to Hoods Pond and the main stem of Beaver Brook. Most of these deposits are considered to have coarse-grained material but have low transmissivity values of less than 1000 ft^2/day because of shallow depths of less than 20 feet deep (Flanagan and Stekl, 1992). However, a section the stratified-drift aquifer located within the Beaver Brook river valley and near where I-93 crosses over Beaver Brook has transmissivity values of 1000 to 2000 ft^2/day and up to 2000 to 4000 ft^2/day for a small section just upgradient or east of the highway crossing (Flanagan and Stekl, 1992). The Town of Derry has an inactive municipal well located within this upgradient portion of the aquifer but has not used the well since the early 1980s. The municipal water system that supplies the western portion of the Town of Derry is connected to the Manchester Water Works system.

About 0.7 mile of the existing I-93 roadway is within the portion of the stratified-drift aquifer associated with the Beaver Brook crossing. The Exit 4-Interchange area is located outside of the stratified-drift area and nearly 2.0 miles of the existing roadway in between Exit 4 and the Stonehenge Road underpass to the north is within the stratified-drift area associated with the tributary to Wheeler Pond.

Further north in the study area, about a 0.4 mile section of existing I-93, just north of Exit 5, is within the Cohas Brook portion of this stratified-drift aquifer. Another section of the existing I-93 roadway, consisting of roughly 2.0 miles, starting just south of the Londonderry/Manchester town line and continuing northward to the I-93/I-293 Interchange is within this same stratified-drift aquifer. All of this section of existing roadway is within the low transmissivity portions of the aquifer. There are

no municipal or community wells within the Cohas Brook portion of the aquifer. A small area about 1500 feet east and upgradient of the I-93 roadway, near the Londonderry/Manchester town line, is considered to have transmissivity values of up to 4000 ft^2/day.

Bedrock aquifers generally pertain to the groundwater contained in the void space in fractures of crystalline bedrock. The yield potential for bedrock aquifers depends on the size and density of the fractures and is typically lower than that of overburden wells that are located in stratified-drift aquifers. Bedrock aquifers are often relied upon for private and small public water supply wells. Within the study area, the greatest density of bedrock wells appears to be in the town of Windham, near the Exit 3 Interchange. More details on public wells located in the project area are provided in the next section.

3.4.2.2 Public Wells

The NHDES Water Supply Engineering Bureau, under the Drinking Water Source Protection Program, monitors the status and maintains data on all public water supply wells throughout the State. Pursuant to State law (RSA 485), a public water supply well is defined as a piped water system, serving 15 or more services or 25 or more people for at least 60 days per year. Public supply wells are categorized into the following groups:

- **Community Well** – A well servicing 15 or more connections, or 25 or more of the same people for 365 days per year. (Serving residential homes or buildings such as apartments, condominiums, mobile home parks, etc.)

- **Non-Community Well** – Any non-residential well servicing 15 or more connections, or 25 or more people either in a Non-transient or Transient Facility as defined below:

  - **Non-transient** – 15 or more services or 25 or more of the same people at least 180 days of the year. (Includes schools, daycare facilities, office buildings and commercial facilities with permanent employees).

  - **Transient** – 15 or more services, or 25 or more different people, at least 60 days per year (Includes restaurants, motels, ski areas and campgrounds).

Table 3.4-3 and **Figure 3.4-2** present information for sixteen (16) public water supply wells that are located within 2000 feet of the existing I-93 roadway according to the data provided by the NHDES Water Supply Engineering Bureau (April 2002). There are four residential, community well systems serving either single family homes or

Table 3.4-3
Public Water Supply Wells Located Within the Project Area

Well No.[1]	Town	Facility Name	Status	WHPA Radius[2]	System Type[3]
1	Salem	Salem Rest Area (NHDOT)	Inactive	NA[4]	N
2	Windham	Pennichuck Water Co. (4 wells) West Shore Road	Active	4000 ft	C
3	Windham	Berges Realty Range Road, Rte. 111A	Inactive	NA	P
4	Windham	Semiconductor Circuits, Inc. (2 wells) Route 111	Active	1200 ft	P
5	Windham	Sisters of Mercy –Searles Property - 21 Searles Road	Active	2000 ft	C
6	Windham	Yankee Trader 115 Indian Rock Rd. Rte 111	Active	NA	N
7	Windham	Plaza 93-Dunkin Donuts Route 111	Active	NA	N
8	Windham	Castleton Banquet Facilities 92 Indian Rock Rd	Active	NA	N
9	Windham	Early Years Kindergarten 71 Indian Rock Rd	Active	1300 ft	P
10	Windham	McCauley Common Condos 37 Searles Road	Active	2000 ft	C
11	Windham	Taylors Country Day Care 125 North Lowell Road	Active	1300 ft	P
12	Windham	Taylors Ballroom 122 North Lowell Road	Active	NA	N
13	Windham	Go-Go Mart 132 North Lowell Road	Active	NA	N
14	Londonderry	Boumil Grove Condos 1 Charleston Avenue	Active	1500 ft	C
15	Londonderry	Applewood Learning Center 1 Palmer Drive, Rte 102 (East)	Inactive	NA	P
16	Londonderry	PEU/Springwood Hills Seasons Lane	Inactive[5]	NA	C

Notes:
1 Well No. refers to the well numbers presented in **Figure 3.4-2**.
2 WHPA radius as measured from NHDES public well location maps (April 3, 2002).
3 System type refers to:
C=Community well serving residential customers or buildings (i.e., homes, condominiums, mobile homes, etc.)
P=Non-community, non-transient supply well serving 25 or more of the same people at least 180 days of the year (i.e., businesses, day-care, schools, etc.).
N=Non-community, transient supply wells serving 25 or more different people at least 60 days of the year (i.e., restaurants, motels, campgrounds, etc.).
4 NA= Not applicable for non-community, transient wells or not available for other inactive well systems.
5 This public water system is now connected to the Manchester Water Works system and does not rely on the existing wells.

multi-family complexes including the Pennichuck Water Company wells next to Canobie Lake, the Sisters of Mercy well serving the Searles Castle property in Windham, the wells for the McCauley Commons Condominiums off Searles Road in Windham, and the wells serving the Boumil Grove Condominiums in Londonderry. The Well Head Protection Area (WHPA) radius around these wells ranges from 1,500 to 4,000 feet. There are three non-residential, community wells servicing the Early Years Kindergarten/Day Care facility in Windham, the Semiconductor Circuits, Inc. facility along Route 111 in Windham and Taylor's Day Care in the Windham Depot area. The WHPA radius around these wells ranges from 1200 to 1300 feet. There are five non-community, transient wells that service the Castleton Banquet Facility, the Plaza 93 and the Yankee Trader facilities along NH 111 in Windham and Taylor's Ballroom and the Go-Go Convenience Store in the Windham Depot area. NHDES as a general policy has not established WHPAs around non-community, transient wells generally because they have much lower production rates. There are four wells that are listed as inactive including the well serving NHDOT's Rest Area in Salem, the Berges Realty well in Windham, the Applewood Learning Center and the Springwood Hills wells off Seasons Lane in Londonderry.

The largest community well system pertains to three bedrock wells located off West Shore Road, next to Canobie Lake that are owned and operated by the Pennichuck Water Works, Inc. These wells supply drinking water to about 200 nearby homes and businesses along the West Shore Road area in Windham. These wells are located about 400 feet east of the existing I-93 roadway and the northbound on and off ramps at Exit 3. Another bedrock well serving the Boumil Grove condos in Londonderry is the only other community well that is located relatively close (i.e., < 500 feet) to the existing I-93 roadway. The other two residential, community wells are located about 1500 feet away and upgradient of the I-93 roadway. There are several businesses served by non-community, transient wells that are within 500 feet of the existing I-93 roadway including the Castleton Banquet Facility, the Plaza 93 and the Yankee Trader in Windham. All of the other wells are about 1,000 feet or more from the existing I-93 roadway.

NHDES has developed *Recommendations for Groundwater Protection Measures When Siting or Improving Roadway in WHPAs* (NHDES 1995). NHDES recommends a graduated, increasing scale of various protection measures depending on the well capacity, distance from the new or reconstructed roadway and whether the roadway is within the well's WHPA. The recommendations apply to existing community or non-community, non-transient public supply wells. These measures and their applicability to the present project are discussed in greater detail in Section 4.4.2.

In response to comments on the DEIS and as a result of additional water quality sampling efforts conducted between December 2002 and May 2003, existing sodium and chloride data for each of the active public wells is presented in Table 3.4-4. The data consists of a combination of the available data reported by the NHDES Drinking Water Source Program and the data collected through the NHDOT Road Salt Sampling Study, previously discussed in Section 3.4.1.3 (NHDOT 2003). Seven wells

that had little to no existing sodium and chloride data in the NHDES files were selected for sampling as part of the NHDOT study.

Table 3.4-4
Sodium and Chloride Data for the Active Public Wells Along the I-93 Corridor

Well No.[1]	Facility Name	NHDES Data				NHDOT Study (2002/03)		
		Date	Source[2]	Sodium (mg/l)	Chloride (mg/l)	Date	Sodium (mg/l)	Chloride (mg/l)
2	Pennichuck Water Co West Shore Rd (4 wells)	12/02/96 8/26/98 10/18/99 11/02/01 6/20/02	Tap Tap Tap Well 4/ 3 Tap	27.1 15.7 19.5 20.9/25.0 20.0	148.0 169.0 162.0 126/333 193.0	ns	--	--
4	Semiconductor Circuits, Inc. Rte 111	09/08/00	001	14.0	47.0	ns	--	--
5	Sisters of Mercy – Searles Property	04/07/00	001	14.8	40.0	Ns	--	--
6	Yankee Trader 115 Indian Rock Rd	.09/02/97 06/03/02	001 001 lunchrm sink	ns 106.0	360.0 307.0	1/22/03 2/13/03 3/14/03 5/9/03	82 98 87 80	320 320 320 310
7	Plaza 93-Dunkin Donuts Rte 111	03/07/01	001- rest room sink	171.0	136.0	1/22/03 2/13/03 3/14/03 5/9/03	150 180 170 150	180 200 190 180
8	Castleton Banquet Facilities	04/30/03	003-mens room sink	17.3	45.0	1/22/03 2/13/03 3/14/03 5/9/03	17 17 15 16	13 11 10 42
9	Early Years Kindergarten 71 Indian Rock Rd	No data	Inside sink	—	—	1/22/03 2/13/03 3/14/03 5/9/03	3.7 3.7 2.8 2.7	2.9 2.6 <5.0 <5.0
10	McCauley Common Condos 37 Searles Rd	10/07/99 10/08/02	001 001	6.1 7.0	3.0 3.0	ns	--	--
11	Taylors Cntry Day Care 125 North Lowell Road	03/15/01	001	18.1	29.0	1/22/03 2/13/03 3/14/03 5/9/03	29 86 76 89	23 22 21 32
12	Taylors Ballroom 122 North Lowell Rd	4/18/03	501- sink	20.9	77.0	ns	--	--
13	Go-Go Mart 132 North Lowell Rd	No data	001 rest room sink	—	—	1/22/03 2/13/03 3/14/03 5/9/03	100 85 77 71	40 37 40 43
14	Boumil Grove Condos 1 Charleston Avenue	09/28/98 09/27/01	002	ns 30.9	260.0 30.0	1/22/03 2/13/03 3/14/03 5/9/03	57 ns 62 27	180 ns 170 32

Notes:
1 Well Number refers to the well location symbol as shown on **Figure 3.4-2**.
2 Source number sometimes refers to different onsite wells or different sampling locations within the same water supply system.
ns Not sampled.

The data reveals a wide range of sodium and chloride concentrations amongst the various wells. The Early Years Kindergarten well located along Route 111 in Windham had some of the lowest concentrations and were consistently below 5.0 mg/l for both sodium and chloride. This well is a bedrock well that is located about 100 to 150 feet upgradient of existing Route 111[27]. The Pennichuck Water Works (PWW) wells and the well serving the Yankee Trader building (Citizens Bank) had some of the highest concentrations. The PWW wells are treated with potassium chloride to address problems with hardness, which would explain the high chloride concentrations and relatively low sodium concentrations. If road salt was the primary source of the elevated concentrations, then sodium concentrations would expected to be around 80 to 100 mg/l or roughly within 30 to 40 percent of the chloride concentrations, since road salt is composed of about 40 percent sodium and 60 percent chloride. In this well, the sodium concentrations are only about 10 to 15 percent of the corresponding chloride concentrations.

The Yankee Trader (Citizen Bank) facility well generally had a ratio of sodium to chloride concentrations that were typical of road salt contributions. This well is located on Route 111 within the Exit 3 Interchange area and could be affected by road salt use in the Route 111 and I-93 Interchange area. The property owner confirmed that the onsite well was not used for drinking water purposes, but is only used to supply the internal plumbing facilities. Bottled water is provided for drinking water.

The well at Plaza 93 (Dunkin Donuts) had sodium and chloride concentrations that were somewhat elevated but not at a ratio that is typical of road salt contributions. The sodium concentrations were nearly the same as the chloride concentrations and, on one previous occasion, the sodium concentration was higher than the chloride concentration. This again may be due to an onsite treatment process, which could not be confirmed through the property owner.

Three other wells more or less consistently had higher sodium concentrations than chloride concentrations including the wells at the Castleton Banquet Facility, the Go-Go Mart and Taylor's Country Day Care. This is either due to the naturally occurring levels of each ion or due to a chemical additive such as sodium hydroxide that may be used as part of a treatment process. As discussed earlier, given the typical composition of road salt, sodium concentrations that were higher than chloride concentrations would not be indicative of the effects of road salt.

The sampling for the Boumil Grove Condominium well showed that the chloride concentrations were somewhat elevated during the winter months but then dropped considerably in non-winter months as shown on the May 9, 2003 event. The ratio of sodium to chloride concentrations appears consistent of road salt composition on at least two occasions but on other occasions the sodium and chloride concentrations are

[27] Under the Selected Alternative, this well will be downgradient of the relocated Route 111.

essentially the same. Previous NHDES data collected in 1998 indicates an observed chloride concentration of 260 mg/l, which slightly exceeds the secondary drinking water standard of 250 mg/l. According to the water consultant that performs routine compliance sampling for this well, this well has no water treatment system (M. Widdison, US Water Consultants, Inc., Pers. Comm., February 2003). This well is located in Londonderry about 500 feet west of the I-93 roadway and just south of Exit 4 Interchange. This well also appears to be located within sand and gravel deposits and downgradient of the I-93 roadway given an apparent east to west groundwater flow direction. The data also indicates the both the sodium and chloride concentrations drop significantly during non-winter months.

3.5 Floodplains

Floodplains within the study area are shown on Flood Insurance Rate Maps for each of the study area communities. The limits of the 100-year floodplains are depicted on **Figure 3.5-1** for the study area. Also shown are the watercourse reaches with designated Regulatory Floodways.

Salem, Windham, Derry, Londonderry and Manchester have adopted local regulations governing development within the areas designated as special flood hazard areas on FEMA's Flood Insurance Rate Maps (FIRM). The regulations generally require a local permit for work within the 100-year floodplain, and provide for development to meet standards consistent with federal requirements for construction within floodplains. In general, the project proponent must demonstrate that a proposed action will not cause more than a one-foot increase in the existing 100-year flood level.

In addition, all five municipalities in the study area have local ordinances prohibiting encroachments within the "Regulatory Floodway" that would result in any increase in flood levels within the community during the base (100-year) flood discharge. The "Regulatory Floodway" is generally defined as the channel of a river or other watercourse and the adjacent land areas that must be reserved to discharge the base flood without cumulatively increasing the water surface elevation more than one foot at any point. Along watercourses that do not have a designated Regulatory Floodway, no encroachment is permitted within specified zones on each community's FIRM, unless the applicant demonstrates that the cumulative effect of the proposed development, when combined with all existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point in the community.

Potential floodplain crossings or encroachments, that may be of concern, occur at the Spicket River, Policy Brook, and Porcupine Brook in Salem; Canobie Lake, Cobbetts Pond, and a tributary of Golden Brook in Windham; Beaver Brook near the Derry/Londonderry town line; two tributaries to Beaver Brook, one in Derry and one in Londonderry; and Cohas Brook and Long Pond Brook in Manchester.

Of the floodplains in the study area, the following may involve encroachment or crossing of regulatory floodways:

- Spicket River in Salem
- Beaver Brook in Derry and Londonderry
- Tributary D – Beaver Brook in Londonderry
- Cohas Brook in Manchester

A brief description of major floodplains that may be affected follows:

Spicket River at Southern Boundary of Salem

The 100-year floodplain in this vicinity varies in width up to approximately 1,600 feet, with a 300-foot floodway. The drainage area at this point is 61.6 square miles, with a base flood peak discharge of 1,900 cubic feet per second (cfs), and a mean floodway velocity of 1.1 feet per second (fps). The base flood elevation data are available from profiles furnished in the Flood Insurance Study for the Town of Salem.

Policy Brook and Porcupine Brook in Salem

Floodplain descriptive data are not available for the reaches of these brooks located within the existing I-93 corridor. Also, floodplain elevation data are not indicated on the FIRM panels for these reaches.

Canobie Lake and Cobbetts Pond, Windham

No descriptive data are furnished for the Canobie Lake or Cobbetts Pond floodplains, and elevation data are not listed for these areas in the Flood Insurance Study for Windham or on the FIRM panel.

Tributary A - Golden Brook

Existing I-93 crosses the upper reach of this tributary. The floodplain varies in width, from approximately 200 to 450 feet at the existing embankment crossings. Elevation data are not given on the FIRM for this reach.

Beaver Brook at Derry/Londonderry Town Line

The 100-year floodplain at this location varies in width, from roughly 500 to 900 feet on the FIRM panels for Derry and Londonderry. The regulatory floodway is approximately 300 feet in width.

The drainage area of Beaver Brook at this point is 26.3 square miles, and the base flood peak discharge is 1860 cfs, with a floodway mean velocity of 1.5 fps. Base flood elevations for this reach are identified in the Flood Insurance Studies for Derry and Londonderry.

Wheeler Pond in Londonderry

The 100-year floodplain to Wheeler Pond consists of two tributary (south-flowing) watersheds in the vicinity of Londonderry Road and Dickey Street. The floodplain boundaries all lie within 1,000 feet and are parallel to I-93 study corridor.

Pillsbury Road Tributary (Tributary D) of Beaver Brook in Londonderry

The 100-year floodplain of this reach lies to the east of I-93 and criss-crosses Londonderry Road. The floodplain and floodway are variable in width in this vicinity **(refer to Figure 3.5-1)**. At the closest point to I–93, the base floodplain is generally 100 to 250 feet wide, with a regulatory floodway of 10 to 20 feet wide. Floodway mean velocity ranges from 2.3 to 7.9 fps, with the upper value occurring at the uppermost limit of the Tributary D drainage area. At the town limits, this tributary has a drainage area of 1.5 square miles and a base flood peak discharge of 245 cfs.

Cohas Brook (Great Cohas Brook) in Manchester

The Cohas Brook has an extensive floodplain area intertwined with the interchange of I-93 with I-293/NH 101. The floodplain configuration is complex **(Figure 3.5-1)**. The regulatory floodway at the crossing by the I-93 embankments is 125 to 150 feet wide, with an estimated mean velocity for the 100-year flood of 2.6 to 2.9 fps. The nearest downstream location for which flood discharge data is furnished in the Flood Insurance Study is South Willow Street, where the contributing watershed is about 66 square miles, and the base flood discharge is 3600 cfs. Floodplain elevation data are provided for the Great Cohas Brook in the Flood Insurance Study for Manchester.

3.6 Land Resources

This section describes the existing conditions within the study area for land resources including geology and soils, farmlands, wetlands, and wildlife. The descriptions provide both an inventory of the resources and a baseline for comparison of future conditions with the project as described in Chapter 4 – Environmental Consequences.

■

3.6.1 Geology and Soils

The study area lies geographically in what has been called the Seaboard Lowland section of the New England physiographic province, one of the subdivisions of the Appalachian Highlands (Fenneman, 1938). The area is generally composed of low rolling hills that rise 100 to 300 feet above the river valleys. There is no pronounced topographic trend, although in the central portion of the study area there is a somewhat northwesterly trend. The lowest point in the study area is along the Massachusetts border in Salem -- approximately 110 feet above sea level. The highest point, Warner Hill, is in central Derry at 605 feet above sea level. Jenny's Hill in

Windham reaches 500 feet, while the area near the Bridge Street overpass on I-93 in Windham is 510 feet above sea level.

The project lies entirely within the drainage basin of the Merrimack River, which flows southerly on the western edge of several of the towns in the study area. Several major tributaries drain the study area: Cohas and Little Cohas Brooks in the northern third, Beaver Brook in the middle third, and Golden Brook and the Spicket River system in the southern third. Lakes and ponds of various sizes are present in the study area and range in elevation from approximately 150 to 290 feet above sea level. The largest, Massabesic Lake in Manchester, is 251 feet elevation. It flows into Cohas Brook. Beaver Lake in Derry is 287 feet above sea level and drains into Beaver Brook. Cobbetts Pond at 177 feet elevation in Windham drains into Golden Brook. Numerous ponds and lakes are located in the Spicket River watershed including Canobie Lake (elevation 219 feet), Seavey Pond (246 feet), Shadow Lake (159 feet), Millville Lake (136 feet) and Arlington Mill Reservoir (160 feet).

Much of the present landscape character in the study area is the result of continental glaciation that occurred between 10,000 and one million years ago during the Pleistocene Epoch. As the glacier moved from the northwest to southeast, it scoured and smoothed the underlying bedrock, picking up soil, rock, and other debris. These materials were later deposited as glacial drift when the ice sheet melted.

The bedrock of the study area is metamorphic rock consisting of schists and granulites that are probably of the Silurian and Devonian age, and plutonic gneisses of the Late Devonian age. Most of the bedrock, from the Massachusetts border almost to the Londonderry-Manchester border, belongs to the Silurian Merrimack Group. The northernmost portion of the study area is underlain by Late Devonian Massabesic gneiss that consists chiefly of pink biotite-microline gneiss.

Plutonic rocks form several bodies in the study area. The Ayer grandiorite forms one five-mile long body that intersects I-93 at the Windham-Salem boundary near Canobie Lake. A foliated binary granite body 11 miles long intersects I-93 in Londonderry. The rocks in the study area dip very steeply and are part of a synclinal structure trending northeast. The synclinal axis of this structure transects the study area.

In some places glacial till was "dumped" in oval-shaped hills called drumlins, one of which is located just north of Exit 2 on the south side of I-93. Ice-contact deposits were formed within and alongside glaciers that moved through the valleys in the study area. Glacial outwash and stratified drift deposits are found in the Beaver Brook and Cohas Brook stream valleys of the study area.

Several pro-glacial lakes formed in the larger stream basins of the study area including Glacial Lake Methuen (near Exit 2), Glacial Lake Golden Brook (near Cobbetts Pond), and Glacial Lake Derry (in the Bear Brook Valley beginning just south of Exit 4 and extending north along the I-93 corridor). As the meltwater streams entered these lakes, the fine-grained sediments settled out forming

sequences of sand, silt, and clay deposits -- referred to as glacio-lacustrine deposits up to 30 feet in thickness. These deposits overlay the till and outwash deposits.

The study area also contains swamp deposits of the Halorene age that contain muck, peat, silt and sand. These are scattered throughout the study area, overlying the glacial till. These deposits, usually five to ten feet thick, formed from accumulating organic materials in depressional areas.

Soils series as described in the soil survey maps produced by the Natural Resources Conservation Service (NRCS) for Rockingham County and Hillsborough County (Eastern Part) were each grouped into the categories based on predominant parent material or land-use. Seven major soil categories were identified in the I-93 study area (**Figure 3.6-1**). These major parent material or land use categories are:

- Glacial Till
- Glacio-Fluvial Deposits
- Marine/Lacustrine
- Alluvial Deposits
- Peat
- Gravel pits
- Urban or Made Land

Soils derived from glacial till are the most common type identified within the I-93 corridor area. Glacial till, which comprises approximately 62.3 percent of the study area, is spread uniformly across the region and generally provides the base from which the other soil parent materials were derived following glaciation.

Glacial-fluvial soils cover 17.2 percent of the study area. Glacial-fluvial deposits are the sandy or silt loam textured soils that developed from eroded material carried, then deposited by glacial streams and floods. Soils derived from glacial-fluvial deposits occur in three major bands across the region. Each of these bands occur in proximity to the major river systems located in the area (Cohas Brook, Beaver Brook and Porcupine/Policy Brook). The well drained Canton and excessively drained Windsor series are common around Cohas Brook. The somewhat poorly to poorly drained Pipestone series dominates the glacial-fluvial soils around Porcupine and Policy Brooks in the Salem area. While the moderately well drained Deerfield and excessively drained Hinckley soils can be found around Beaver Brook in the Londonderry/Derry area.

Urban or made land makes up 6.2 percent of the study area. Urban or made land includes any areas identified in the soil series maps that consist mainly of sandy or gravely fill material that has been placed on terraces, floodplains, and uplands. The amount of fill that may have been placed varies from 20 inches to 20 feet. Similarly, urban or made land also includes any areas where 85 percent or more of the land area is covered with buildings, asphalt or concrete. Typically, these areas include business districts, industrial parks and shopping centers.

Gravel pit areas, which include open excavations from which gravel or sand have been removed, make up 2.0 percent of the study area. Excavations of granite, areas commonly identified as quarries, are also included under this category. Most pit areas range in size from 2 to 40 acres.

■

3.6.2 Farmlands

3.6.2.1 Important Farmland Soils

The four categories of important farmland soils, addressed in the Farmland Protection Policy Act (FPPA) of 1984, include prime farmland, unique farmland, farmland of statewide importance, and farmland of local importance. In addition, active farmland or agriculture areas are discussed. Each farmland category is described below:

1. **Prime Farmland** is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when the land is treated and managed using acceptable farming methods. Prime farmland produces the highest yields with minimal inputs of energy and economic resources and causes the least damage to the environment. Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. It also has a favorable temperature and growing season and acceptable acidity or alkalinity. It has few or no rocks and is permeable to water and air. Prime farmland is not excessively erodible or saturated with water for long periods and either does not flood frequently or is protected from flooding. The slope ranges mainly from 0 to 8 percent. Prime farmland may now be in crops, pasture, or woodland, but not urban and built-up land or water areas. It must either be used for producing food or fiber or be available for these uses.

2. **Unique Farmland** is land other than prime farmland that is used for the production of specific high value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods. Examples of such crops in New Hampshire are apple orchards, lowbush blueberries, vegetable truck gardens, and maple sugar groves.

3. **Farmland of Statewide Importance** is land, in addition to prime and unique farmlands, that is of statewide importance for the production of food, feed, fiber, forage, and oilseed crops. Generally, these farmlands include those areas

that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods.

4. **Farmland of Local Importance** includes certain additional farmlands for the production of food, feed, fiber, forage, and oilseed crops.

Figure 3.6-2 depicts the categories of farmland as identified from NRCS soil survey maps and from windshield surveys within the I-93 study area.

In general, the designation of prime farmland and farmland of statewide and local importance is based on soils characteristics. The NRCS for Rockingham County and the NRCS for Hillsborough County provided a list of soil map units identified as prime farmland and farmland of statewide and local importance.[28] This information, including the soil name and associated map symbol, is shown in Table 3.6-1 and **Table 3.6-2**. Unique farmland soils have not been classified by the NRCS in either Rockingham or Hillsborough Counties.

Table 3.6-1
Important Farmland Soils, Rockingham County

Prime Farmland	
Map Symbol	**Soil Name[1]**
532 A	Belgrade sil
32A	Boxford sil
62 A,B	Charlton fsl
38 A,B	Eldridge fsl
37A, B	Melrose fsl
44 A,B	Montauk fsl
66 A,B	Paxton fsl
460 B	Pennichuck channery vfsl
4	Pootatuck fsl
446 A,B	Scituate-Newfields complex fsl
68 A, B	Sutton fsl
30A	Unadilla vfsl
29 A,B	Woodbridge fsl

1 sil = silt loam; fsl = fine sandy loam; vfsl = very fine sandy loam; gfsl = gravelly fine sandy loam; lfs = loamy fine sand; ls = loamy sand

[28] The Derry, Londonderry, Salem, and Windham portions of I-93 Study Area are located within Rockingham County, while the City of Manchester lies within the eastern part of Hillsborough County.

Table 3.6-1 (Continued)

Farmland of Statewide Importance	
Map Symbol	**Soil Name**[1]
46 A,B,C	Acton fsl
532 B	Belgrade sil
32 B	Boxford sil
42 B,C	Canton gfsl
62 C	Charlton fsl
510 A,B,C	Hoosic gfsl
37 C	Melrose fsl
10 A,B,C	Merrimack fsl
44 C	Montauk fsl
66 C	Paxton fsl
460 C	Pennichuck channery vfsl
531 B	Scio vfsl
446 C	Scituate fsl
14 A,B	Sudbury fsl
31 B,C	Suffield sil
68 C	Sutton fsl
30 B	Unadilla vfsl
29 C	Woodbridge fsl
Farmland of Local Importance	
43 B	Canton gfsl, very stony
63 B	Charlton fsl, very stony
313 A	Deerfield fsl
305	Lim-Pootatuck complex
45 B	Montauk fsl, very stony
67 B	Paxton fsl, very stony
533	Raynham sil
646 A	Ridgebury vfsl
656 A	Ridgebury vfsl
5	Rippowam-Pootatuck complex
33A	Scitico sil
538 A	Squamscott fsl
546 A	Walpole vfsl
26 A,B	Windsor ls

1 sil = silt loam; fsl = fine sandy loam; vfsl = very fine sandy loam; gfsl = gravelly fine sandy loam; lfs = loamy fine sand; ls = loamy sand

Table 3.6.2
Important Farmland Soils, Hillsborough County (Eastern Part)

Map Symbol	Soil Name[1]
Prime Farmland	
AgA	Agawam fsl
AgB	Agawam fsl
BaA	Belgrade sil
BdA, B	Bernardston Variant vfsl
MoB	Montauk fsl
NnA, B	Ninigret vfsl
Oc	Occum fsl
Om	Occum fsl, high bottom
PbB	Paxton fsl
PhB	Pennichuck fsl
PtA, B	Pittstown Variant loam
Pu	Pootatuck fsl
WoA, B	Woodbridge loam
Farmland of Statewide Importance	
BaB	Belgrade sil
BdC	Bernardston Variant vfsl
CaB, C	Canton fsl
CpB	Chatfield-Hollis-Canton fsl
MoC	Montauk fsl
PbC	Paxton fsl
PhC	Pennichuck fsl
SsA, B, C	Scituate fsl
Farmland of Local Importance	
BeC	Bernardston Variant stony vfsl
CmB, C	Canton stony fsl
DeA, B	Deerfield lsf
MtB, C	Montauk stony fsl
PfB, C	Paxton stony fsl
StA, B	Scituate stony fsl
Su	Suncook lfs
WdA, B	Windsor ls
WvB	Woodbridge stony loam

1 sil = silt loam; fsl = fine sandy loam; vfsl = very fine sandy loam; gfsl = gravelly fine sandy loam;
lfs = loamy fine sand; ls = loamy sand

3.6.2.2 Active Farmland

Active farmlands are lands that are currently in active agricultural use. These lands were identified from aerial photos and windshield surveys, and include only those lands in, or adjacent to, the I-93 corridor. Actively farmed land includes a cornfield in the southeast quadrant of Exit 1; truck gardens in Salem along South Policy Road west of I-93; hay fields and pastures in Windham on the north and south side of NH111A west of I-93, and along the south side of Lowell Road and east side of Morrison Road east of I-93; an extensive orchard (Woodmont) in Londonderry along the south side of Pillsbury Road just north of Exit 4; and hayfields also in Londonderry along the east side of Noyes Road west of I-93; and hayfields in Manchester along the west side of Mammoth Road west of I-93. No active farmland was identified in Derry within the study corridor.

■

3.6.3 Wetland Resources

Studies over the past few decades have found that wetlands provide habitat for numerous aquatic plant and animal species, and function in the protection and enhancement of surface and groundwater resources. Wetlands help to filter and purify water by trapping soil particles along with the pollutants they carry before these pollutants enter watercourses. Wetlands have an ability to absorb nutrients such as nitrogen and phosphorus, and later release these nutrients when they are less likely to degrade water quality. Wetlands act to regulate the release of stormwater by acting as temporary storage basins, which can lower flood crests and reduce the destructive potential of severe storms. Wetlands stabilize the shores along rivers and lakes, and further buffer the destructive forces of storms by absorbing the impact of waves. These actions alone can protect vast areas of shoreline property. Some wetlands also augment groundwater supplies by passing surface water and direct precipitation through the wetland soil into the underlying aquifers. The realization that wetlands provide certain functions and values from which the general public may benefit has led to the passage of Federal, State and local wetland laws and ordinances.

Federal protection is accorded wetlands under Section 404 of the Clean Water Act and Section 10 of the Federal Rivers and Harbors Act. The U.S. Army Corps of Engineers (Corps) is charged with the duty of overseeing and regulating activities in wetlands at the Federal level. The U.S. Environmental Protection Agency (EPA) also reviews projects that may impact wetlands and has veto authority over discharges they find unacceptable.

The State of New Hampshire regulates activities in wetlands under RSA 482-A, which grants regulatory authority to the NH Department of Environmental Services Wetlands Bureau (NHWB).

Communities in New Hampshire possess, at minimum, recommendation authority to the NHWB as to whether a permit to dredge or fill wetlands should be issued. The

bulk of this recommendation responsibility is placed on the local conservation commissions. Individuals concerned about the protection of wetlands for certain projects generally express their concerns through the local commissions.

Communities also have the ability to enact their own ordinances to regulate activities in wetlands. Four of the five communities affected by the I-93 improvement have wetland protection ordinances in place. The City of Manchester does not have a wetland conservation district. Most communities designate these areas subject to local jurisdiction as Wetland or Conservation Districts. The land area subject to a local wetland or conservation ordinance varies from community to community.

Within the study area, both Salem and Derry have afforded additional protection to wetlands under RSA 482-A:15, by which a community may designate certain wetlands "prime wetlands", which requires additional review and scrutiny of projects affecting these areas. Evaluative methodologies are employed by municipalities to determine functions and values of selected wetlands to designate as prime. The municipality holds a public hearing to vote on the designation. If approved by the community, the DES is provided with documentation substantiating the nomination. Upon approval of the submission, DES will apply the applicable rules to any project within or adjacent to a prime wetland. To this end, all projects that are in or adjacent to prime wetlands are classified as major projects. Prime wetland projects require field inspections and public hearings to be held by DES.

3.6.3.1 Wetland Occurrence

Identification of Wetlands

At present in New Hampshire, the Federal and State regulatory agencies identify and delineate wetlands based on a three-parameter approach, which considers plants, soils and hydrology in the interpretation of the wetland/upland boundary. These agencies identify wetlands according the 1987 Corps of Engineers Wetland Delineation Manual (1987 Manual), that was developed and prepared by the U.S. Army Corps of Engineers (ACOE).

Wetland cover types in the study area have been identified according to the U.S. Fish and Wildlife Service (USFWS) classification system (Cowardin et al., 1979). The USFWS classification system uses a hierarchy broken into systems, subsystems, classes, and subclasses to categorize wetlands and deepwater habitats. Systems (marine, estuarine, riverine, lacustrine and palustrine) refer to the type of hydrologic setting in which the wetlands are found (or in relation to) i.e. oceans, estuaries, rivers, lakes and other vegetated non-tidal wetlands. Along the I-93 project corridor only palustrine or riverine systems exist. The following types of cover type classifications were mapped (described later), and include areas of palustrine forested (PFO), palustrine emergent (PEM), palustrine scrub/shrub (PSS), palustrine open water

(POW) systems, riverine open water unknown bottom (ROW), riverine unconsolidated bottom (R3UB), and riverine intermittent stream (R4SB).

Palustrine systems include all non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens and other wetlands in tidal areas with low salinity. Areas mapped as PFO cover type are forested wetlands containing vegetation that is 20 feet tall or taller in the overstory, and contain an understory of younger trees or shrubs, and an herbaceous layer. The PEM cover type refers to areas dominated by erect, rooted , herbaceous hydrophytes, excluding mosses and lichens. The vegetation is present for most of the growing season in most years. Wetlands mapped as PSS include areas dominated by woody vegetation less than 20 feet tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. Scrub-shrub wetlands may represent a successional stage leading to forested wetland, or they may be relatively stable communities. POW refers to wetlands that contain small ponds or areas of ponded water that are too deep to support emergent plants. They may be surrounded by other palustrine cover types or may be small depressional areas with steep banks surrounded by upland. In most cases, wetlands identified and assessed within the I-93 corridor are associated with streams (named and unnamed), and ponds and lakes. These surface water resources are described in detail in Section 3.4.1.

Riverine systems include wetlands and deepwater habitats contained within a channel, with two exceptions: wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and habitats with water containing ocean-derived salts in excess of 0.5 parts per thousand (not found within the I-93 corridor). Upland islands or palustrine wetlands may occur in the channel, but they are not included in the riverine system. Areas mapped as ROW are those having non-tidal deeper water, where the stream bottom (typically sands, mud and organic matter) is submerged most of the time. Areas designated as R3UB are swifter moving systems located further upstream in the watershed with stream bottoms consisting of some or all of the following materials: cobble-gravel, sand, mud and organics. The R4SB designation refers to streams that flow intermittently and have a variety of stream bottom materials, i.e., bedrock, rubble, cobble-gravel, sand, mud, organic, and vegetated. Riverine systems along the I-93 corridor for the most part are bordered by palustrine wetland systems.

In 1989, a delineation and general assessment of wetlands in and around I-93 from Salem to Manchester was performed for the NHDOT. A detailed delineation of wetlands for the area within the median of I-93 was conducted, and a more cursory examination and delineation of wetlands was completed for the areas outside of, but adjacent to, the northbound and southbound barrels of I-93. Wetland delineation criteria were based on the 1989 Federal Manual, which is similar to the 1987 Manual but uses more conservative parameters resulting in more conservative (more wetland area) boundaries. Wetland systems were identified and delineated on 1" = 50' scale topographic maps provided by the NHDOT. Corps transect data sheets justifying placement of the wetland/upland boundary within the I-93 median area were also completed.

Additionally, National Wetland Inventory (NWI) maps, prepared by the U.S. Fish and Wildlife Service, were reviewed to determine the extent of wetlands within the project corridor. NWI maps show wetlands across a region based on wetland hydrology and a preponderance of certain vegetative communities. These maps are available in digital format from Complex Systems at the University of New Hampshire for interpretation in ARC INFO software under a Geographic Information System (GIS). NWI maps from this computer mapping system were combined with the wetlands delineated and identified in 1989 to produce the wetland boundaries shown on **Figure 3.6-3** (General Wetlands).

During July 1998, the wetlands within the I-93 corridor were field reviewed. Using the 1987 Manual, previous wetland delineations were revised and updated on wetland base maps. Also during July 1998, preliminary wetland delineation was extended to the first major intersection beyond the immediate interchange areas for Exit 1 to Exit 5. The wetlands shown on **Figure 3.6-4** include the July 1998 revisions and extensions of preliminary wetland mapping for the project area. The state-designated prime wetlands and wetlands of local importance are sub-categories of wetlands established by the five municipalities that comprise the study area and are shown on the figure. The location of vernal pools is also included on **Figure 3.6-4**. (For a detailed discussion of vernal pools, see Sections 3.6.4.3 and 4.6.4).

Prime Wetlands

The towns of Salem and Derry have designated some wetlands as prime wetlands. When so designated by individual towns, these wetlands take on a level of regulatory importance higher than wetlands not so designated. In effect, prime wetlands cannot be impacted unless the project is public in nature; mitigation will provide replacement of all functions and values, and the impacts are truly unavoidable. As such, prime wetlands are given special consideration in the analysis of alternatives for proposed development activities.

According to the NHWB, 24 areas of wetlands are designated as prime in Salem, and 29 areas are considered prime wetland in Derry. Of these 53 prime wetlands, six areas occur within one-half mile east or west of I-93. Within the highway corridor, two areas of prime wetlands are located each in Salem, and Derry. In Salem, a portion of prime wetland #16 is located west of Exit 1. Portions of prime wetland #17 are located east of Exit 1, south of Rockingham Park Boulevard, and to the east and west of the highway, north of Exit 1. In Derry, prime wetland #6F is crossed by I-93, south of Fordway. Prime wetland #7F is located to the east of the highway, north of prime wetland #6F. Prime wetlands were reviewed and updated by professional wetland scientists during July 1998. Following a town vote, portions of the two wetlands in Salem, listed as prime, were de-listed in 2001. The updated distribution of prime wetlands is shown on **Figure 3.6-4**.

3.6.3.2 Description of Wetland Systems/ Functions and Values

Twenty-seven wetland systems were identified and assessed within the I-93 project corridor in April and May 2002. Comprising roughly 475 acres in total, the wetland systems are grouped according to hydrologic connectivity, location within watersheds or subwatersheds, or are split along existing manmade features such as roadways. Locations of wetland systems within the project corridor are shown on **Figure 3.6-3**. Areal extent (acreage) of wetlands is calculated from the area contained within designated wetland system boundaries shown on the figure.

The majority of wetlands throughout the project study area comprise a network of interconnected systems contained within five major watersheds and several subwatersheds. In general, wetlands located within the southern one-third of the project corridor are more disturbed, altered, and fragmented than those in the northern two-thirds. Proximity to existing roads and commercial and residential development have degraded portions of most wetlands from the Massachusetts border extending to the weigh stations in Windham. Other wetlands, north of the weigh stations to the northerly project terminus, have been adversely affected to a lesser degree by adjacent land development.

Using the Highway Methodology Workbook Supplement (ACOE, 1999), function and value assessments were performed in April and May 2002 at 56 locations in the vicinity of potential impacts within the project corridor. The locations where assessments were performed are shown on **Figure 3.6-5** (Wetlands Systems Functions and Values). One wetland system function and value box was prepared for each wetland system, representing a composite of individual assessments performed within each of the 27 systems. Total wetland acreage and a summary of their functions and values are provided in Table 3.6-3.

Some of the larger wetland systems within the corridor contain several habitat types, allowing a wide range of assessed functions and values. Other wetlands have limited functions and values due to their location near the highway, other roadways or developed land. In these areas, wetland edges in many locations are degraded and/or altered. Illegal dumping of debris and trash, and sediments (from drainage culverts and runoff) have degraded wetland areas that extend for 50 feet or more from the roadway edge in some locations. In addition, off-road vehicle use is occurring within and along wetland edges in many areas along the highway.

Table 3.6-3
Summary of Wetland Resources Within the I-93 Study Corridor

Wetland Number	Wetland Name	Watershed	Total Wetland Area (acres)	Cover Type(s)	Ground water Recharge/ Discharge	Floodflow Alteration	Fish and Shellfish Habitat	Sediment/ Toxicant Retention	Nutrient Removal	Production Export	Sediment/ Shoreline Stabilization	Wildlife Habitat	Recreation	Educational/ Scientific Value	Uniqueness/ Heritage	Visual Quality/ Aesthetics
1	Policy Brook/Spicket River	Spicket River	3.7	PFO, PEM, POW	X	0	0	0	X	0	X	0	X		0	X
2	Spicket River Tributary	Spicket River	22.3	PFO, PEM		0	X	0	X		X	0				
3	Porcupine Brook Tributary	Spicket River	40.2	PFO, PEM, POW, PSS	X	0		0	X	X	X	0				X
4	Porcupine Brook	Spicket River	21.5	PFO, PEM, PSS	X	0	0	0	X	X	X	0				X
5	Exit 2	Spicket River	13.1	PFO, PEM, PSS	X	0	X	0	0	X	X	0				X
6	Policy Brook	Spicket River	13.1	PFO, PEM	X	0	0	0	0	X	X	0				X
7	Porcupine Brook Tributary	Spicket River	1.0	PFO, PEM	X	0		0	X		X	0				X
8	Canobie Lake South Tributary	Spicket River	2.3	PFO, PSS	X	0		0	X		X	0				X
9	North Tributary to Policy Brook	Spicket River	2.0	PFO	0	X		0	X		X	0				X
10	Canobie Lake West Tributary	Spicket River	8.3	PFO, PEM, PSS	X	0	X	0	0	0	X	0			X	X
11	Route 111A	Spicket River	28.6	PFO, PEM, POW	X	0	X	0	0	0	X	0			X	X
12	Exit 3	Golden Brook	19.8	PFO, PEM, PSS,POW	X	0	0	0	0	0	X	0			X	X
13	Route 111	Golden Brook	17.1	PFO	X	0	X	0	0	0	X	0	X	0	0	X
14	Weigh Stations South	Golden Brook	5.4	PFO, PEM	X	0	X	0	0	X	X	X				X
15	Weigh Stations North	Golden Brook	11.6	PFO, PEM	X	0		0	0	X	X	0				X
16	Bridge Street Pond	Spicket River	7.1	PFO, PSS	X	0		0	0	X	X	0	X			
17	Windham North	Spicket River	14.9	PFO, PSS		0		0	X	X	X	X	X			
18	Derry South	Spicket River	11.8	PFO, PSS, PEM	X	0		0	0	X	0	0				X
19	Derry Central/North	Beaver Brook	16.9	PFO, PEM, POW	0	0	0	0	0	X	X	0				X
20	Beaver Brook	Beaver Brook	23.5	PFO, PEM, PSS	X	0	0	0	0	X	X	0				X
21	Wheeler Pond and Tributary	Beaver Brook	15.4	PFO, PEM, PSS	X	0	0	0	0	X	X	0	X	X	X	0
22	Pillsbury Road to PSNH Easement	Beaver Brook	28.5	PFO, PEM, PSS, POW	X	0	X	0	0	X	X	0	X		X	X
23	Stonehenge Road	Beaver Brook	13.5	PFO, PEM, POW	X	0		0	0	X		0				
24	Londonderry Central	Little Cohas Brook	10.9	PFO, PEM, PSS	X	0		0	0	X	X	0			0	X
25	Exit 5	Little Cohas Brook	46.7	PFO, PEM, PSS	X	0	0	0	0	0	X	0	X	X	X	0
26	Cohas Brook	Cohas Brook	31.7	PFO, PEM, PSS	0	0	0	0	0	X	X	0				X
27	I-93/I-293 Interchange	Cohas Brook	45.0	PFO, PEM, PSS	X	0	0	0	0	0	X	0			0	0

Data based on VHB Field Evaluation conducted April – May 2002
X = Function/Value Present
0 = Principal Function.
Note: No known populations of wetland-dependent threatened or endangered species are present in the study area.

Wetland System 1 – Policy Brook/Spicket River

Wetland System 1 is a riverine system (R3UB) associated with Policy Brook and the Spicket River located east of the highway and north of the New Hampshire and Massachusetts border in Salem. Totaling 3.7 acres, areas of PFO and PSS lie adjacent to the stream and river. Surrounding areas include residential, farmland and industrial properties and forested uplands. Portions of the wetland nearest the highway are littered with trash and debris.

Policy Brook was apparently altered and straightened during the original highway construction as it flows parallel from a point north of the Exit 1 Rest Area to its confluence with the Spicket River just north of the border. A rest area detention basin (PEM) contributes drainage to the brook. Layers of sediments (sand and silt) are found in forested areas adjacent to the deeply cut channel, suggesting recent and frequent flooding events. Dominant vegetation in areas of PFO adjacent to the stream and along the banks include red maple (*Acer rubrum*), swamp white oak (*Quercus bicolor*), and eastern white pine (*Pinus strobus*). Small areas of PSS are vegetated mostly with highbush blueberry (*Vaccinium corymbosum*), silky dogwood (*Cornus ammomum*), and glossy buckthorn (*Rhamnus frangula*).

Wetland System 1 supports eleven of the thirteen standard functions and values in wetland systems. The wetland's principal functions are floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, production export, wildlife habitat and uniqueness. Bordering the Spicket River, the wetland is mostly located within the 100-year floodplain, retaining higher volumes of water during flood events than under normal conditions. The wetland also supports a high density of vegetation that takes up water, as well as providing stabilization and retention of sediments and toxicants. The stream and wetland are easily observed by the public from several viewing locations along I-93, and an extensive community of river birch (*Betula nigra*) is located southeast of the river/stream confluence approximately 150 feet east of the highway.

Wetland System 2 – Harris Brook Tributary

Wetland System 2 is located in Salem, to the west of the highway near the state boundary and extending to Brady Road. Totaling 22.3 acres, and primarily a large area of PFO, smaller strips of PSS and PEM occur along the edge of an intermittent stream (R4SB) that is tributary to Harris Brook. Wetland System 2 was apparently segmented from Wetland System 1 by the construction of I-93. The tributary stream flows into Harris Brook (which flows into the Spicket River) south of the state border. Forested areas and residential development are located in surrounding locations to the west of Wetland System 2. Litter and debris are found along the edge of the highway into the wetland edge and intermittent stream. Vegetation in the PFO includes red maple, highbush blueberry, glossy buckthorn, eastern white pine, cinnamon fern (*Osmunda cinnamomea*), sensitive fern (*Onoclea sensibilis*), and tussock sedge (*Carex stricta*).

Wetland System 2 supports six of the standard functions and values found in wetland systems. Principal functions include floodflow alteration, sediment/toxicant retention, and wildlife habitat. Dense residential development located near the northern two-thirds of this system has impacted the system by reducing the areal extent of the wetlands, increasing nutrient loading, and fragmenting wildlife habitat.

Wetland System 3 – Porcupine Brook Tributary

Wetland System 3 is a riverine wetland system (R3UB), and includes areas of PFO, PEM, and PSS (totaling 40.2 acres) adjacent to, and within, the Exit 1 Interchange, south of Route 38 in Salem. Porcupine Brook and its perennial tributary flow through the wetland system. Porcupine Brook enters the system east of the northbound on-ramp. The tributary is culverted through the interchange from the west, and ultimately joins with Policy Brook east of the project corridor. Vegetation in areas of PFO is dominated by red maple, highbush blueberry, and eastern white pine. Areas of PEM are vegetated with cattail (*Typha latifolia*), purple loosestrife (*Lythrum salicaria*), sensitive fern, reed-canary grass (*Phalaris arundinacea*), and soft rush (*Juncus effusus*). Vegetation in the small areas of PSS adjacent to the southbound on-ramp includes glossy buckthorn, highbush blueberry, gray birch (*Betula populifolia*), and meadowsweet (*Spiraea latifolia*).

Wetland System 3 supports eight of the standard wetland functions and values. Principal functions include floodflow alteration, sediment/toxicant retention, and wildlife habitat. Apparent historical drainage ditches are located within the PFO south of the tributary stream. Further west of the interchange, areas of PFO and PEM are expansive and largely undisturbed. The Town of Salem designated these areas as prime wetlands. South of Rockingham Park Boulevard and east of the project area, the PEM and PSS bordering Porcupine Brook is designated as prime wetland, although the vegetation is largely comprised of purple loosestrife, an invasive species. Some areas within the interchange are also degraded with trash and roadway sediments due to direct discharge of stormwater. Invasive plant species also limit the potential of these areas to provide as many functions as wetlands located further from the roadway to the west.

Wetland System 4 – Porcupine Brook

Wetland System 4 is located in Salem, north of Route 38 and includes a riverine and palustrine wetland system associated with Porcupine Brook (R3UB). Comprising 21.5 acres, areas of PFO and PSS to the east and west of I-93, and within the median, are included in wetland system. Vegetation within Wetland System 4 consists primarily of red maple, glossy buckthorn, highbush blueberry, silky dogwood, and tussock sedge.

Wetland System 4 supports nine of the standard functions and values found in wetland systems. Principal functions include floodflow alteration, fish and shellfish habitat, sediment/toxicant removal and wildlife habitat. The western portion of the wetland bordering Porcupine Brook occupies a large 100-year floodplain and retains higher volumes of water during flood events than under normal conditions.

Sedimentation of the watercourse within the median probably limits use of this stretch of the brook by fish and shellfish. An abundance of vegetation promotes potential sources of sediment and toxicant retention as well as nutrient removal. Porcupine Brook is a Class B stream and has sufficient food sources to attract wildlife. Evidence of use of the wetland system by beaver and ducks was observed. Two sections of Wetland System 4 (one each to the east and west of the highway) have been designated as prime wetlands by the Town of Salem. These areas are predominantly forested wetlands dominated by red maple.

Wetland System 5 – Exit 2

Wetland System 5 (13.1 acres in total), is located in Salem, west of and within the southbound on and off ramps at the Exit 2 Interchange. Areas to the north and south of NH 97 (Pelham Road) are included in this system, which drains to Porcupine Brook located to the south. Wetland System 5 includes larger areas of PFO, and PEM, and narrow sections of PSS that exhibit degradation due to roadway runoff and sedimentation, and littering with trash and debris. Red maple, eastern white pine, gray birch, highbush blueberry, cinnamon fern, and mosses (*Sphagnum* spp.) dominate vegetation in the areas of PFO. Areas of PSS and PEM (located within the southbound on and off ramps) are dominated by glossy buckthorn, speckled alder (*Alnus rugosa*), winterberry holly (*Ilex verticillata*), common elderberry (*Sambuca canadensis*), meadowsweet, sensitive fern, tussock sedge, cattail, and purple loosestrife.

Wetland System 5 supports nine of the standard functions and values found in wetland systems. Principal functions include floodflow alteration, sediment/toxicant retention, nutrient removal, and wildlife habitat. Highly developed surrounding land, (primarily industrial and commercial) limits some wetland functions of this system. Excessive sedimentation and dumping of trash and debris were noted.

Wetland System 6 – Policy Brook

Wetland System 6 is located in Salem, east of I-93 and includes areas to the north and south of Pelham Road that drain to the east and south towards Policy Brook. The stream flows southward through an area of PFO and is culverted beneath Pelham Road. Areas of PSS and PEM are also present within Wetland System 6, south of Pelham Road. Total wetland area contained in this system is 13.1 acres. Vegetation includes red maple, swamp white oak, highbush blueberry, arrow-wood (*Viburnum dentatum*), witherod (*Viburnum cassinoides*), cinnamon fern, and Sphagnum mosses. Items of trash and debris are located in wetlands south of Pelham Road.

Wetland System 6, in areas north of Pelham Road, supports nine of the standard functions and values found in wetland systems. Principal functions in these areas include floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, and wildlife habitat. This wetland system has the ability to absorb and detain excess water during flood events and diffuses water flow. The wetland has a high density of vegetation that takes up water as well as providing stabilization and retention of sediments and toxicants. The wetland also supports wildlife habitat

and its high density of vegetation supplies a good food source for wildlife. In areas south of Pelham Road, commercial, light industrial and residential development is located near these wetland systems which are largely degraded due to sedimentation, and refuse and debris dumping. Principal functions in these areas are limited to sediment/toxicant removal, floodflow alteration, and nutrient removal.

Wetland System 7 – Porcupine Brook Tributary

Wetland System 7 is located in Salem, north of Exit 2 and south of Brookdale Road. The wetland system, consisting of small areas of PFO, PSS and PEM comprising 1.0 acre, is associated with an intermittent tributary stream (R4SB) that flows from north to south beneath the highway and west to Porcupine Brook. Surrounding development contributes stormwater and runoff directly to the wetland system, which exhibits signs of degradation evidenced by surface and filamentous algae in areas of ponded water contained within wooded areas. Areas of PFO located immediately to the east and west of the highway are vegetated with red maple, gray birch, yellow birch (*Betula allegheniensis*), poison ivy (*Toxicodendron radicans*), elderberry, highbush blueberry, common winterberry, and cinnamon fern. An area of PEM, located within the highway median is vegetated largely with common reed (*Phragmites australis*), with lesser amounts of purple loosestrife, cattail and species of sedges (*Carex* spp.).

Wetland System 7 supports seven of the standard functions and values found in wetland systems. Principal functions are floodflow alteration, sediment/ toxicant retention and wildlife habitat. Limited by its small size, the area of PEM located within the median, provides some nutrient removal in addition to sediment/toxicant retention.

Wetland System 8 – Canobie Lake South Tributary

Wetland System 8 is located in Salem, north of Brookdale Road, near the Windham municipal boundary. Totaling 2.3 acres, areas of PFO, PSS, and PEM, slowly drain to Canobie Lake located to the north. Dominant vegetation within areas of PFO consist of red maple, eastern white pine, swamp white oak, highbush blueberry, cinnamon fern, and poison ivy. Areas of PEM and PSS are vegetated with red maple, highbush blueberry, sweet pepperbush (*Clethra alnifolia*), arrow-wood, swamp fetterbush (*Leucothoe racemosa*), swamp azalea (*Rhododendron viscosum*), maleberry (*Lyonia ligustrina*), glossy buckthorn, cattail, and tussock sedge.

Wetland System 8 supports seven of the standard functions and values found in wetland systems. Principal functions include floodflow alteration, sediment/toxicant retention, and wildlife habitat. A relatively diverse shrub plant community could provide habitat and food sources for wildlife. However, surrounding residential development and the adjacent highway, fragment the potential habitat. Trash, debris and reduced water quality (large amounts of filamentous and surface algae), were noted in some areas.

Wetland System 9 – North Tributary to Policy Brook

Wetland System 9, comprising 2.0 acres, is located in Windham, southwest of Canobie Lake. Drainage from wetlands (PFO) in this area is directed away from Canobie Lake by a shallow intermittent stream (R4SB) that is culverted beneath the northbound lane then back under the roadway further south eventually draining into Policy Brook. Vegetation in Wetland System 9 consists mainly of red maple, swamp white oak, black birch (*Betula lenta*), eastern white pine, highbush blueberry, and cinnamon fern.

Wetland System 9 supports seven of the standard functions and values. Principal functions include groundwater recharge/discharge, sediment/toxicant retention, and wildlife habitat. Roadway sediments, trash/debris, and iron staining within the drainage channel was noted within wetland areas nearest the highway, indicated degraded conditions within the wetland.

Wetland System 10 – Canobie Lake West Tributary

Wetland System 10 is located in Windham, west of Canobie Lake. Totaling 8.3 acres in size, areas of PFO, located to the east and west of the highway, and PEM, located within the median, characterize the wetland cover types in this system. A perennial tributary (R3UB) flows through the wetland system from west to east to Canobie Lake. Surrounding land use is primarily residential. Dominant vegetation within areas of PFO includes red maple, yellow birch, common winterberry, highbush blueberry, and cinnamon fern. The area of PEM within the median is vegetated with cattail, purple loosestrife, common reed, reed-canary grass, species of horsetail (*Equisetum* spp.), and blue flag (*Iris versicolor*).

Wetland System 10 supports ten of the standard functions and values found in wetlands. Principal functions include floodflow alteration, sediment/toxicant retention, nutrient removal, production export, and wildlife habitat. An area of well-established *Phragmites* (an invasive species) at the southern end of the marsh, within the median, is limiting some functions of this wetland system.

Wetland System 11 – Route 111A

Wetland System 11 is a large wetland system (28.6 acres) located in Windham, south of NH 111A. Much of the wetland area (PFO, PSS, POW, and PEM) is located within the I-93 median. Drainage from the system flows northward through the median then eastward, finally outletting on the north side of Canobie Lake. Vegetation in areas of PFO and PSS includes red maple, swamp white oak, species of ash (*Fraxinus* spp.), speckled alder, common winterberry, highbush blueberry, silky dogwood, elderberry, poison ivy, and cinnamon fern. Areas of PEM are primarily vegetated with cattail, sensitive fern, and purple loosestrife. Lesser amounts of silky dogwood, speckled alder, and common winterberry are found at the marsh edges. Vernal Pool 6 is located in an area of forested and scrub/shrub wetland within the I-93 median, south of the median crossover.

The diversity of wetland types within Wetland System 11 supports ten of the standard functions and values. Principal functions include floodflow alteration, sediment/toxicant retention, nutrient removal, production export, and wildlife habitat. The large marsh located within the median and to the east of it, provide an expansive area for floodwaters to be retained. A constricted outlet located beneath the northbound lane limits outflow from the system allowing long settling times for sediments and toxicants and nutrient uptake by dense vegetation within the marsh.

Wetland System 12 – Exit 3

Wetland System 12, located within Windham, adjacent to and within the Exit 3 Interchange. Areas of PFO, POW, PSS, and PEM totaling 19.8 acres comprise Wetland System 12. Two unnamed perennial streams (R3UB) flow through the area from north to south, beneath NH 111 to Cobbetts Pond. Vegetation includes red maple, eastern white pine, speckled alder, common winterberry, gray birch, cattail, purple loosestrife, buttonbush (*Cephalanthus occidentalis*), sensitive fern and tussock sedge.

In part, due to a diversity of cover types, Wetland System 12 supports ten of the standard functions and values found in wetland systems. Principal functions are floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, production export and wildlife habitat. The Wetland System flows into Cobbetts Pond through a constricted outlet that slows water movement and allows for sediment and toxicants to settle out of suspension and be absorbed by emergent vegetation. Perennial tributaries provide suitable habit for establishment of fish species. The wetland system also supports groundwater recharge/discharge, sedimentation retention, production export, wildlife habitat, and uniqueness functions. Private wells located downstream indicate the system contributes to groundwater recharge. Food production of the system contributes to the wildlife populations in the area, songbirds and other species were observed during field surveys.

Wetland System 13 – Route 111

Wetland System 13 is located along NH 111, west of I-93 in Windham. PFO, POW, PSS, and PEM wetland cover types (totaling 17.1 acres) are all found within this system. Several intermittent streams (R4SB) are located in this wetland system, which drains to Cobbetts Pond, located to the south. Vegetation in areas of PFO and POW includes red maple, swamp white oak, sweet pepperbush, highbush blueberry, arrow-wood, swamp rose, spicebush (*Lindera benzoin*), cinnamon fern, and *Sphagnum* mosses. Pronounced hummock/hollow topography is found within the bouldery surfaces of the forested wetland areas. Areas of PEM and PSS are vegetated with cattail, purple loosestrife, meadowsweet, speckled alder, and tussock sedge.

A diversity of wetland types in Wetland System 13 supports twelve of the standard functions and values found in wetland systems. Principal functions are floodflow alteration, sediment/toxicant retention, nutrient removal, production export, wildlife habitat, educational/scientific value, and uniqueness. A tributary of Golden Brook

flows through the area and its sinuosity contributes to flow diffusion, sediment retention and nutrient removal. Interspersion of upland and wetlands throughout the area contributes to wildlife habitat diversity and provides ample food sources. An important local landmark, Indian Rock, is situated north of Route 111 in an upland area between areas of forested wetland.

Wetland System 14 – Weigh Stations - South

Wetland System 14, totaling 5.4 acres, is located in Windham, south of the drainage divide that bisects the weigh stations located between Exits 3 and 4. Drainage from the areas of PFO, portions of which are located within the highway median, outlet to tributaries (R4SB) of Golden Brook located west of the highway. A small area of POW (Vernal Pool 13) is located within the highway median within a larger area of PFO. Probably the most degraded vernal pool habitat identified within the corridor, its location in the highway median is probably a factor limiting its use by breeding amphibians. Vernal Pool 22 (PFO) is also located within the system, to the west of the southbound lane, opposite the acceleration lane from the weigh station. Vegetation in areas of PFO includes red maple, yellow birch, arrow-wood, eastern hemlock (*Tsuga canadensis*), eastern white pine, highbush blueberry, cinnamon fern, and *Sphagnum* mosses.

Wetland System 14 supports nine of the standard functions found in wetland systems. Principal functions are floodflow alteration, sediment/toxicant retention, and nutrient removal. Dense vegetation and long detention times contribute to the wetland system's ability to remove sediment, toxicants, and nutrients. The wetland system also supports wildlife habitat. Evidence of degradation to wetlands within the median include areas of direct sedimentation and siltation due to untreated stormwater runoff, and debris and trash along the highway shoulders and wetland edges.

Wetland System 15 – Weigh Stations - North

Wetland System 15 is located in Windham, directly north of Wetland System 14, and includes areas 11.6 acres in size, of PFO and PEM located within the median and to the east and west of the highway. Vegetated with many of the same species as Wetland System 14, areas of PFO in this system drain westward to a tributary (R4SB) to Golden Brook. Areas of PEM are vegetated with cattail, tussock sedge, reed-canary grass, and emergent woody shrubs. Located at the northern end of the weigh station, the area of PEM conveys drainage to a vegetated drainage basin located east of the paved parking area associated with the weigh stations. Observed use of the area of PEM, as amphibian-breeding habitat (Vernal Pool 15A), was documented during fieldwork.

Wetland System 15 supports eight of the standard functions found in wetland systems. Principal functions include floodflow alteration, sediment/toxicant retention, nutrient removal, and wildlife habitat. Bordering Golden Brook, a large portion of this wetland system is located within 100-year floodplain and retains higher volumes of water during flood events than under normal conditions. The forested wetland to the east of the corridor supports a high density of vegetation that

is able to attenuate nutrients. A high diversity in plant community structure indicates the potential use of the wetland by wildlife.

Wetland System 16 – Bridge Street Pond

Wetland System 16, located in Windham, south of North Lowell Road, includes areas of POW (Bridge Street Pond) and PFO west of the highway, and PEM/POW east of the highway. Total wetland area within the system amounts to 7.1 acres. Dominant vegetation includes red maple, cattail, purple loosestrife, arrow-wood, and reed-canary grass. Surrounding land use is predominantly residential.

Wetland System 16 supports eight of the standard functions and values. Principal functions include floodflow alteration, sediment/toxicant retention, nutrient removal, and wildlife habitat. Use of the wetlands and upland areas adjacent to wetlands by off-road vehicles was evidenced by the presence of deeply cut and meandering dirt trails in several locations.

Wetland System 17 – Windham North

Wetland System 17 is located in Windham north of North Lowell Road and south of the Derry municipal border. Totaling 14.9 acres, areas of PFO (including isolated depressions) dominate the wetland cover type found in this system. Wetland System 17 drains to the east toward Flat Rock Brook. Small areas of PEM, located closer to the highway, appear to be receiving less drainage in recent years as evidenced by dense areas of red maple shrubs and saplings located in communities dominated by emergent herbaceous plants. Other vegetation includes eastern white pine, black birch, arrow-wood, maleberry, highbush blueberry, common winterberry and tussock sedge. Surrounding land use consists primarily of residential development.

Wetland System 17 supports seven of the standard functions and values found in wetland systems. Principal functions are floodflow alteration and sediment/toxicant retention. Vernal Pool 18 is located in a small area of depressional PFO located within this wetland system east of the highway.

Wetland System 18 – Derry South

Wetland System 18 is located in Derry, north of the Windham municipal boundary. Totaling 11.8 acres, wetland cover types include PFO and POW located to the east of the highway and PFO and PEM located west of the highway. This wetland system drains to the east toward Flat Rock Brook. Vernal Pool 18 is located in a small area of depressional PFO. Vegetation in areas of PFO is dominated by red maple and highbush blueberry. Areas of PEM include cattail and tussock sedge, and some sections are impacted by extensive use of off-road vehicles. The wetland is adjacent to a mix of residential, civic/institutional, and recreational/open space/agricultural. Land to the east is labeled as Prime Farmland.

Wetland System 18 supports eight of the standard thirteen functions found in wetland systems. The wetland's principal functions are floodflow alteration, sediment/toxicant retention, nutrient removal, sediment/shoreline stabilization, and wildlife habitat. The slow movement of water through this wetland allows nutrients to be retained and processed for use by emergent vegetation. The wetland also supports a high density of vegetation that takes up water as well as providing stabilization and retention of sediments and toxicants. Varied wetland classes yield food sources for wildlife.

Wetland System 19 – Derry Central North

Wetland System 19, comprising 16.9 acres, is located in Derry, north of Wetland System 18 and south of Kendall Pond Road. Consisting mostly of large areas of PEM to the east of the highway, smaller areas of PFO are located at the edges of PEM near the highway and POW is located to the west of I-93. A railroad corridor bisects the area of PEM located to the east of the highway. Dominant vegetation in the wetland system includes red maple, highbush blueberry, cattail, purple loosestrife, elderberry, wool grass (*Scirpus cyperinus*), and tussock sedge. The wetland system, which drains westward via a tributary to Beaver Brook, is adjacent to a mix of residential, open space and agricultural properties.

Wetland System 19 supports nine of the standard thirteen functions and values characteristic of wetland systems. Principal functions are groundwater recharge/discharge, floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, and wildlife habitat. One of the areas of PFO is apparently fed by groundwater that flows along a shallow channel extending from a culvert that drains an area of bedrock outcropping located within the median. No contributing area of surface drainage was observed. The Town of Derry designates the large area of PEM located to the east of the highway as well as the tributary that flows from it west of the highway, as prime wetlands.

Wetland System 20 – Beaver Brook

Wetland System 20 is a riverine and palustrine system located east and west of the highway, straddling the Derry/Londonderry municipal line and extending to the north, just south of Exit 4. Totaling 23.5 acres, the wetland system includes areas of POW, PFO, PSS and PEM that drain to Beaver Brook (R3UB), which flows northeast to southwest through the southern parts of the system. Vegetation within areas of PFO, PSS, and PEM includes red maple, glossy buckthorn, meadowsweet, arrow-wood, speckled alder, American elm (*Ulmus americana*), purple loosestrife, tussock sedge, and skunk cabbage (*Symplocarpus foetidus*). In addition to the previously listed species, vegetation along the deeply cut banks of Beaver Brook includes silky dogwood, elderberry and eastern white pine. Surrounding land use includes residential, recreational, open space, treatment ponds, agricultural fields as well as designated farmland of local importance.

Wetland System 20 supports nine of the functions and values attributable to wetlands. Principal functions include floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, and wildlife habitat. The wetland system is adjacent to four constructed sewer treatment ponds directly north of Beaver Brook's 100-year floodplain. The wetlands bordering Beaver Brook are relatively flat with a moderate density of vegetation that is able to provide flood storage for the surrounding uplands. The slow movement of water through Wetland System 20 allows nutrients to be retained and processed for use by emergent vegetation. The wetland also supports a high density of vegetation that takes up water as well as providing stabilization and retention of sediments and toxicants. There are numerous wetland classes that yield food sources for wildlife.

Wetland System 21 – Wheeler Pond and Tributary

Wetland System 21 is located in Londonderry, north of Exit 4 and south of the Pillsbury Road overpass. Wetland System 21, comprising 15.4 acres, contains PFO, POW, PSS, and PEM cover types. Wheeler Pond makes up the largest portion of Wetland System 21. The eastern edges of the pond have been altered by development (paved surfaces and rip-rap) that extends to the pond's edge. Areas of PEM and PSS fringe the open water area of the pond on the remaining sides. Vegetation in these areas includes red maple, speckled alder, black willow (*Salix nigra*), meadowsweet, cattail, purple loosestrife, sensitive fern, and tussock sedge. Duckweed (*Lemna minor*) was observed in deeper water areas of PEM on the southern side of the pond. An unnamed perennial tributary (R3UB) to Wheeler Pond flows along the eastern edge of the northbound lane and provides food sources and habitat for fish and wildlife. An area of PFO adjacent to the stream was altered by apparent cutting of vegetation and dumping of refuse east of the highway. Surrounding land use consists of limited residential, and is mainly commercial and industrial. A small amount of agricultural land is also located to the west of the system.

Wetland System 21 supports twelve of the standard thirteen functions and values found in wetland systems. Principal functions are floodflow alteration, fish and shellfish habitat, sediment/ toxicant retention, nutrient removal, wildlife habitat and visual quality/aesthetics. The relatively flat conditions of the wetland allow for flood storage. The wetland also supports a high density of vegetation that takes up water as well as providing stabilization and retention of sediments and toxicants. The slow movement of water through the wetland system and bordering Wheeler Pond allows nutrients to be retained and processed for use by emergent vegetation. An active beaver dam is located at the northern edge of the pond.

Wetland System 22 – Pillsbury Road to PSNH Easement

Wetland System 22 is located in Londonderry, between Pillsbury Road and the drainage divide to the north located along the PSNH power line easement. Areas of PFO, POW and PEM, totaling 28.5 acres, are located within the highway median and to the east and west of it. These wetland areas drain southward to the perennial tributary to Wheeler Pond described previously in the Wetland System 21

description. Surrounding land use consists primarily of residential properties. Vegetation within the PFO west of the highway includes red maple, ash, silky dogwood, highbush blueberry, common winterberry, elderberry, American elm, skunk cabbage, and bittersweet (*Celastrus* sp.). Areas of POW and PEM are found east of the highway. Vernal Pools 20 and 21 are located within 100 feet of the roadway edge in these areas. Due to their proximity to the roadway, trash and debris are located within the edge of these seasonally flooded wetlands. Further northward, a dirt trail is located within the wetland in a previously altered area. Vegetation in the areas of PEM includes tussock sedge, buttonbush, common winterberry, red maple, highbush blueberry, speckled alder, arrow-wood, gray birch, and royal fern (*Osmunda regalis*).

Wetland System 22 supports eleven of the standard functions and values found in wetland systems. Principal functions include floodflow alteration, sediment/toxicant retention, nutrient removal and wildlife habitat. Wetland System 22 functions effectively at slowing surface and stormwater flow and diffuses the water prior to entering into the 100-year floodplain downstream of Pillsbury Road.

Wetland System 23 – Stonehenge Road

Wetland System 23, totaling 13.5 acres, is located in Londonderry, north of the PSNH power line easement (drainage divide) to a point just north of Stonehenge Road at the Beaver Brook/Little Cohas Brook watershed divide. Drainage from a large area of PEM is culverted beneath the highway south of Stonehenge Road, and continues eastward to areas of PFO, PSS and POW east of the highway, eventually to Hood Pond which outlets to Beaver Brook in Derry. Dominant vegetation in the wetland system includes red maple, highbush blueberry, common winterberry, cattail and tussock sedge.

Wetland System 23 supports six of the standard functions found in wetland systems. Principal functions are floodflow alteration, sediment/toxicant retention, nutrient removal, and wildlife habitat. Areas of impounded water are able to trap sediments and toxicants. Wetland System 23 has various vegetation classes that provide food and breeding habitat for wildlife.

Wetland System 24 – Londonderry Central

Wetland System 24 is located in Londonderry, north of Wetland System 23 extending to a point just south of the Exit 5 off-ramp. Depressional areas of PFO and PEM are located east of the highway, with narrow strips of PSS found within the highway median. Wetland System 24, comprising 10.9 acres, drains slowly toward Beaver Brook via wetland areas located east of Rockingham Road. Areas of PFO in this system exhibit a hummock/hollow topography and contain diverse plant communities, with nearly thirty species identified. Dominant plants include yellow birch, black birch, red maple, highbush blueberry, arrow-wood, nannyberry (*Viburnum lentago*), common winterberry, rhodora (*Rhododendron canadensis*), cinnamon fern, royal fern, lady fern (*Athyrium filix-femina*), tussock sedge and

Sphagnum mosses. Adjacent land use is primarily residential, with some commercial development located at the northern end of the system.

Wetland System 24 supports nine of the standard functions and values characteristic of wetland systems. Principal functions include floodflow alteration, sediment/toxicant retention, nutrient removal, wildlife habitat, and uniqueness/heritage. Highway drainage to the area is trapped in the depressional areas where toxicants and sediments settle out. Dense layers of vegetation utilize nutrients contained within the stormwater.

Wetland System 25 – Exit 5

Wetland System 25 is a large area (totaling 46.7 acres), located adjacent to and within the Exit 5 Interchange, and extending to the drainage divide, located about 3,000 feet to the north. Wetland areas along Route 28 are also included in Wetland System 25. A railroad corridor bisects the southern end of the pond and PEM, north of NH 28 and a power line easement extends across the highway north of these areas. Drainage from the system flows toward Little Cohas Brook to the west of the highway. Areas of POW, PFO, and PEM are located immediately north of the north and south bound exit ramps. Dominant vegetation in areas of PFO includes red maple, yellow birch, elm, eastern white pine, gray birch, highbush blueberry, arrow-wood, common winterberry, and cinnamon fern. Areas of PSS and PEM (located primarily where stormwater is being conveyed to or from) are vegetated with speckled alder, silky dogwood, gray dogwood (*Cornus racemosa*), glossy buckthorn, gray birch, cattail, purple loosestrife, sensitive fern and tussock sedge. Debris, trash, and sediments were noted in these areas. Land adjacent to Wetland System 25 is mostly developed as residential, commercial and industrial properties.

Wetland System 25 supports twelve of the standard functions and values determined to be attributes of wetland systems. Principal functions include floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, production export, wildlife habitat, and visual quality/aesthetics. The wetland lies in a visible, flat area that has large flood storage potential. The wetland also supports a high density of vegetation that takes up water as well as providing stabilization and retention of sediments and toxicants.

Wetland System 26 – Cohas Brook

Wetland System 26 is a riverine (R3UB) and palustrine forested wetland system located in Londonderry and Manchester, north of the Cohas Brook/Little Cohas Brook watershed divide. The 31.7-acre system, which is primarily located between the north and southbound lanes, extends northward to Bodwell Road where Cohas Brook exits the system. Areas of POW, PFO, PSS, and PEM are associated with the brook, which receives flow from intermittent tributaries (R4SB) located on both sides of the highway and Long Pond Brook located east of the highway. PEM wetlands located east of the highway, and opposite Bodwell Road, showed signs of degradation. Trash, debris and degraded water quality (surface algae mats) were

observed. Vegetation found within Wetland System 26 includes red maple, swamp white oak, yellow birch, black birch, common winterberry, eastern hemlock, eastern white pine, arrow-wood, royal fern, cinnamon fern, meadowsweet, tussock sedge, purple loosestrife, species of bulrush (*Scirpus* spp.), blue flag, cattail, reed-canary grass and duckweed.

Wetland System 26 supports nine of the standard functions and values characteristic of wetland systems. Principal functions are groundwater recharge, floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, and wildlife habitat. Bordering Cohas Brook, wetlands in this system occupy large areas of the 100-year floodplain and retain much higher volumes of water during flood events than under normal conditions. Wetlands bordering the stream support a high density of vegetation that uptake water as well as providing stabilization and retention of sediments and toxicants. The abundance and diversity of vegetation also provides food and shelter for wildlife. Cohas Brook supports fish and provides habitat for various amphibians, reptiles and birds.

Wetland System 27 – I-93/I-293 Interchange

Wetland System 27, is located in Manchester, in the areas surrounding the intersection of I-93 with I-293, and within the highway median. The 45-acre system is comprised of areas of POW, PFO, PSS, and PEM. Cohas Brook flows westward through the southern reaches of the system. Vegetation in areas of PFO and PSS near the stream is similar to that in Wetland System 26. The large area of PEM within the interchange is vegetated mostly with cattail, with lesser amounts of purple loosestrife, and reed-canary grass. Fringes of PSS are vegetated with meadowsweet, gray birch, speckled alder, silky dogwood, highbush blueberry, and alternate-leaved dogwood (*Cornus alternifolia*). Surrounding land use is primarily residential, commercial, recreational and agricultural property.

Wetland System 27 supports ten of the standard functions and values found in wetland systems. The wetland's principal functions are floodflow alteration, fish and shellfish habitat, sediment/toxicant retention, nutrient removal, production export, wildlife habitat, uniqueness/heritage, and visual quality/aesthetics. Bordering Cohas Brook, this wetland occupies a large amount of 100-year floodplain and provides a large area of flood storage potential. The wetland also supports a high density of vegetation that takes up water as well as providing stabilization and retention of sediments and toxicants. The stream and wetland are easily observed by the public from several viewing locations along I-93.

3.6.3.3 Vernal Pools

Vernal pools are ephemeral wetlands that fill annually with water due to precipitation, runoff, and rising groundwater. The pools occur yearly in the same spot, typically in small woodland depressions, kettle holes, oxbows on river floodplains, and gravel pits. In most years these unique wetland areas become

completely dry, losing water through evaporation and transpiration. These wet-dry cycles preclude permanent populations of predatory fish, making these seasonal areas ideal breeding habitat for some amphibians and invertebrates. Viable vernal pools also require adjacent forested upland because the amphibian species disperse to these areas for non-breeding portions of their life cycles. Vernal pools also provide suitable habitat for reptiles and other wildlife.

Certain species (wood frog, spotted salamander, blue-spotted salamander, Jefferson salamander, marbled salamander, and fairy shrimp) depend completely upon vernal pools for parts of their life cycles and are known as indicator or obligate vernal pool species. Other amphibians, reptiles, and invertebrates utilize vernal pools and other types of wetlands for parts of their lifecycles and are known as non-indicator or facultative species.

In 1996, 2001 and 2002, the I-93 corridor from Salem to Manchester was investigated to determine the location and extent of vernal pools. Using New Hampshire Fish and Game Department (NHF&GD) guidelines, visual inspections of the pool's water column, substrate, vegetation and surrounding upland habitat were performed. Photographs were taken of each area inspected. Species identification and counts of aquatic invertebrates and amphibian egg masses, juveniles and adults were made. Physical characteristics such as pool dimension, maximum and average water depth, and water temperature were also noted. The presence (or absence) of vernal pool indicator species (fairy shrimp, wood frog, spotted salamander, blue-spotted salamander, Jefferson salamander, and marbled salamander) determined whether an area was classified as a vernal pool or not. Areas determined to be vernal pools are shown on **Figure 3.6-4**.

In April 1996, an investigation of 19 potential vernal pools concluded that seven of the 19 pools met the criteria used for vernal pool designation. In May 2001, follow-up inspections were conducted on 23 potential vernal pools within the corridor (including those studied in the 1996 study). Of the seven areas previously classified as vernal pools in 1996, six were confirmed to be vernal pools in 2001. Eleven additional areas were designated as vernal pools and six areas were documented as being potential vernal pools in the May 2001 study.

In April 2002, the 23 areas identified as vernal pools or potential vernal pools in the 2001 study were re-examined. Of the 17 areas previously identified as vernal pools, six were determined to have the necessary indicator species. Of the six potential vernal pools identified in 2001, only one was identified as a vernal pool, having the necessary indicator species. Areas were eliminated as vernal pools in 2002 because they lacked indicator species (some of these areas also lacked non-indicator species). In addition, most eliminated pools were nearly or entirely lacking pooled water and/or had water that was degraded or apparently of insufficient quality to support indicator vernal pool species. Several of these areas in 2002 were choked with pine needles, leaves, branches, and debris and the water appeared to be high in tannins. Other areas were littered with trash/debris, had large amounts of filamentous or

surface algae, distinct anaerobic or sulfurous odors, and/or typically supported large populations of mosquito larvae.

In general, areas classified as vernal pools within the I-93 corridor are depressional areas located within wooded habitats and isolated from direct roadway drainage. Although most of the pools studied are located within 100 feet of the roadway, buffering vegetated strips (forested and grassed) appear to provide enough protection to the pools to allow breeding activity to continue. Sufficient upland habitat in the remaining adjacent areas is likely a key factor in maintaining the use of these areas by vernal pool species. A comparison of data obtained in 1996, with confirmatory data collected in 2002, indicates agreement with the number of pools identified within the study corridor.

Following are descriptions of the seven areas, identified as vernal pools, located within the I-93 highway corridor. All data were collected during April 2002. Water temperatures were taken at 6 to 8 inches below the surface.

2002 Vernal Pool Descriptions

Vernal Pool 6

Vernal Pool 6 (VP6) is located south of Exit 3, within the highway median in Wetland System 11. Located about 150 feet west of the northbound lane and 50 feet south of the median crossover road, the pool slowly drains to the north via a partially obstructed metal culvert beneath the crossover road. No direct highway drainage was observed discharging into the vernal pool area. A thick emergent shrub layer and overhanging tree branches provide ample attachment sites within the adequate depths of water in the vernal pool. Numerous wood frog and spotted salamander egg masses were observed in the central portions of the pool. Surrounding upland habitat consists of a mixed deciduous forest along the northern, western and southern edges (preferred by most frog and salamander species), and open grassy highway median along the eastern edge. The northern and eastern edges of the vernal pool show some signs of degraded water quality evidenced by filamentous/surface algae, and anaerobic odors. Items of trash were also observed in the wetland in these areas.

Width: 100 feet **Length:** 200 feet **Water Temperature:** 61ºF
Maximum Water Depth: 2 feet **Average Water Depth:** 1 foot
Pool Substrate: decaying organic matter (leaves, twigs, branches) underlain by thick muck layer over silts and sands
Pool Vegetation: buttonbush, winterberry, red maple, black birch, highbush blueberry, sweet pepperbush, Canada mayflower, tussock sedge, sphagnum moss
Surrounding Upland: mixed deciduous forest vegetated with red oak and eastern white pine
Observed Aquatic Invertebrates: fairy shrimp, fingernail clam, amphibious snail, predacious diving beetle, mosquito larvae
Observed Adult/Juvenile Amphibians: adult wood frog (2)

Observed Indicator Species: fairy shrimp, wood frog egg masses (numerous), spotted salamander egg masses (6), adult wood frog (2)

Vernal Pool 13

Vernal Pool 13 (VP13) is located in Wetland System 14, south of the weigh stations within the median of I-93. Located at the bottom of a steep embankment, within a depressional area about 100 feet from the edge of the northbound lane, overhanging and emergent woody stems provide shade and potential attachment sites for amphibians. The vernal pool drains slowly to the west to an adjacent forested and scrub/shrub wetland. Limited actual use of the area by breeding amphibians was noted during field inspections, as the area appears to be quite degraded due to its proximity to the highway. Surrounding upland habitat consists of deciduous forest with greater amounts of softwood located to the south and west. The amount of upland habitat adjacent to the pool, is restricted by its position in the landscape i.e. within the highway median. VP13 exhibits signs of water quality degradation as evidenced by the presence of surface and filamentous algae.

Width: 30 feet **Length:** 50 feet **Water Temperature:** 48ºF
Maximum Water Depth: 4 feet
Average Water Depth: 2.5 feet
Pool Substrate: decaying organic matter (leaves, pine needles), thick organic muck
Pool Vegetation: eastern hemlock (overhanging), highbush blueberry, winterberry, cinnamon fern
Surrounding Upland Vegetation: deciduous forest vegetated with red oak, eastern hemlock, white pine, gray birch, red maple, American hazelnut, partridgeberry, wintergreen
Observed Aquatic Invertebrates: fairy shrimp, caddisfly larvae, water strider
Observed Adult/Juvenile Amphibians: None
Observed Indicator Species: wood frog egg masses (2), fairy shrimp (few individuals)

Vernal Pool 15A

Vernal Pool 15A (VP15A) is located north of the northbound weigh station in Wetland System 15. Located about 50 feet from the edge of pavement northeast of the weigh station, the vernal pool slowly discharges into a detention basin to the south. Drainage from paved surface does not appear to enter the pool directly. A mix of emergent herbaceous and woody vegetation, and varying amounts of cover over the pool, provides a mix of breeding habitat for amphibians and invertebrates. Water quality within the vernal pool is apparently good as evidenced by a varied number of invertebrates, and as many as 7,500 wood frog eggs contained within numerous masses affixed to herbaceous plants at the surface of the water. Surrounding uplands consist of areas of deciduous and coniferous forest to the north and east. Although bordered by paved areas of the northbound weigh station to the west and detention basin to the south, sufficient habitat exists for adult stages of amphibian life cycles.

Width: 50-75 feet **Length:** 100 feet **Water Temperature**: 46ºF
Maximum Water Depth: 2 feet **Average Water Depth:** 1.5 feet
Pool Substrate: emergent herbaceous deep muck
Pool Vegetation: red maple, highbush blueberry, maleberry, sweet pepperbush, sedges, sensitive fern, cinnamon fern, cattail, reed canary grass
Surrounding Upland: deciduous and coniferous forest vegetated with white oak, eastern white pine, eastern hemlock, American elm, sheep laurel, tree clubmoss
Observed Aquatic Invertebrates: water strider, caddisfly larvae, fingernail clam, isopod, amphipod, amphibious snail, aquatic oligochaete worm
Observed Adult/Juvenile Amphibians: adult wood frog, spring peeper (chorusing)
Observed Indicator Species: wood frog egg masses (numerous), adult wood frog

Vernal Pool 18

Vernal Pool 18 (VP18) is a small area located about 0.5 miles south of the Windham/Derry town line within Wetland System 17. Located approximately 70 feet east of the northbound lane, the isolated depression contains many oak leaves and pine needles. Upland areas adjacent to the vernal pool consist of deciduous and coniferous forest to the north, east and south. To the west, the edge of the highway right-of-way is more sparsely vegetated. A cart path extends through this area and may be used by off-road vehicles. Limited size of the pool, small volume of water, lack of attachment sites, and apparent high water acidity may be limiting factors for breeding amphibians in this pool.

Width: 15 feet **Length:** 30 feet **Water Temperature:** 56ºF
Maximum Water Depth: 2 feet **Average Water Depth:** 1.5 feet
Pool Substrate: oak leaves and pine needles underlain by organic layer over sands
Pool Vegetation: red maple, highbush blueberry
Surrounding Upland: deciduous forest vegetated with eastern white pine, red and white oak, red maple, hazelnut, species of club-moss
Observed Aquatic Invertebrates: fairy shrimp(many), predacious diving beetle, water strider, mosquito larvae
Observed Adult/Juvenile Amphibians: 1 adult wood frog
Observed Indicator Species: fairy shrimp, adult wood frog

Vernal Pool 20

Vernal Pool 20 (VP20) is located in Wetland System 22, approximately 75 feet east of the northbound lane. The pool is 500 feet north of Vernal Pool 21, to which it slowly discharges along the toe of slope of the roadway shoulder. Emergent herbaceous and woody vegetation on the northern and western sides of the pool, provides many attachment sites for egg masses (observed location). Standing dead trees contain bird nesting cavities, and fallen trees throughout the pool are suitable for basking turtles. The surrounding mixed deciduous forested upland, extending for thousands of feet to the north, east and south, is excellent habitat for adult salamanders and reptiles. A large (30-inch) ribbon snake was observed at the edge of pool. Vernal Pool 20 is perhaps of the highest overall quality of those studied within the corridor, as

evidenced by the diversity and number of amphibian, invertebrate, and reptile species. However, water quality at the western edge of the pool is showing some signs of degradation (filamentous algae and litter) due to its proximity to the highway.

Width: 70 feet **Length:** 140 feet **Water Temperature:** 54ºF
Maximum Water Depth: 3 feet **Average Water Depth:** 2 feet
Pool Substrate: thin layer of muck over firm pebbly sand substrate
Pool Vegetation: red maple, buttonbush, cinnamon fern, highbush blueberry, meadowsweet, speckled alder, sensitive fern, skunk cabbage
Surrounding Upland: oak, hickory, and maple deciduous forest
Observed Aquatic Invertebrates: fairy shrimp (many), predacious diving beetle, water boatman, whirligig beetle, water strider, mosquito larvae, caddisfly larvae, fingernail clam, midge larvae
Observed Adult/Juvenile Amphibians: green frog
Observed Indicator Species: wood frog egg masses (10), spotted salamander egg masses (8), fairy shrimp

Vernal Pool 21

Vernal Pool 21 (VP21) is located in Wetland System 22 approximately 1500 feet north of the Ash Street/Pillsbury Road overpass north of Exit 4 and 500 feet south of Vernal Pool 20. Located about 75 feet from the edge of pavement, VP21 is mostly open water and emergent marsh. Many dead trees with bird nesting cavities, and windfalls suitable for basking turtles are located throughout the pool. Emergent shrubs located within the northern and western central areas of the pool provide attachment sites for the egg masses that were observed. Surrounding upland habitat is similar to that adjacent to Vernal Pool 20, and extends for thousands of feet to the north, east and south. Filamentous, surface algae and trash, were noted near the western edge of the pool, indicating water quality degradation, probably due to its proximity to the highway.

Width: 100 feet **Length:** 200 feet **Water Temperature:** 58ºF
Maximum Water Depth: 2 feet
Average Water Depth: 1.5 feet
Pool Substrate: muck layer over silt and fine sands
Pool Vegetation: blue joint grass, reed canary grass, cattail, speckled alder, red maple, highbush blueberry, meadow-sweet, water lily, sensitive fern, cinnamon fern
Surrounding Upland: forested wetland and upland vegetated with red maple, oak, white pine, hazelnut, tree club-moss.
Observed Aquatic Invertebrates: water strider, mosquito lavae, caddisfly larvae, water mite, fingernail clam, midge larvae, predacious diving beetle, whirligig beetle
Observed Adult/Juvenile Amphibians: hatching spotted salamanders
Observed Indicator Species: wood frog egg masses (3), spotted salamander egg masses (8) and hatching juveniles

Vernal Pool 22

Vernal Pool 22 (VP22) is located in Wetland System 14, approximately 100 feet south of the southbound weigh station. Located about 50 feet from the edge of pavement near the acceleration lane from the weigh station, the pool is located in a depressional area and segmented from the highway shoulder by a dirt haul road. The pool may be located in an old borrow pit as suggested by historic (highway construction) and active (logging and off-road vehicles) land use in the area. Surrounding upland habitat to the south, west and north consists of moderate to steeply sloped deciduous forest. Water quality is apparently good in VP22, as evidenced by abundant numbers of amphibian indicator species.

Width: 30-40 feet **Length:** 80-100 feet **Water Temperature:** 56ºF
Maximum Water Depth: 4 feet
Average Water Depth: 2.5 feet
Pool Substrate: branches and leaves underlain by a thick organic muck layer over silt and fine sands
Pool Vegetation: red maple, witch hazel, fetterbush, American elm, sensitive fern
Surrounding Upland Vegetation: oak, white pine, hazelnut, witch hazel
Observed Aquatic Invertebrates: fairy shrimp, caddisfly larvae, water strider, predacious diving beetle
Observed Adult/Juvenile Amphibians: None
Observed Indicator Species: spotted salamander egg masses (8), fairy shrimp

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3.6.4 Wildlife Resources

New Hampshire has 318 species of terrestrial wildlife (vertebrates other than fish) species that occur as either migrants or residents. This variety of wildlife species is valuable to the state both economically relative to tourism and recreational activities, and as integral components of ecological food webs, energy flow, and biodiversity.

The U.S. Fish and Wildlife Service (USFWS) is responsible for managing and protecting migratory wildlife species. Except for threatened and endangered species and their associated “critical habitats”, Federal protection of wildlife on private property is confined to migratory species and is not extended to their habitat.

The NHF&GD is responsible for managing and protecting resident wildlife species. NHF&GD has promulgated rules (NH Administrative Rules Fis Chapter 1000) for the protection and management of these species. These rules pertain almost entirely to the exploitation of the species and not to the habitats. The rules set seasons, bag limits, and legal means for the taking of game, fish, and furbearing species.

Some wildlife habitat is protected as state forests, state parks, or state-owned or state-managed wildlife management areas where additional restrictions on land use apply. In 1987 the NHF&GD made public a resolution encouraging the protection of deer

wintering areas (deer yards) through education, cooperative agreements, leases, easements, and acquisitions. However, no blanket legal protection was given to deer yards on privately owned lands.

Wildlife and wildlife habitats that are considered to be important issues in land development include deer yards, high quality wetlands, waterfowl nesting habitat, vernal pools, and heron rookeries. Also, other natural ecological communities or habitats are valued for their rarity, uniqueness of their biotic assemblages (in a regional context), or high natural biodiversity or abundance of wildlife.

3.6.4.1 Existing Resources

The USFWS, NHF&GD, New Hampshire Natural Heritage Inventory (NHNHI), Audubon Society, Southern New Hampshire Regional Planning Commission, Rockingham Planning Commission, and the Conservation Commissions of Manchester, Londonderry, Derry, Windham, and Salem, were contacted about available information on the past, present, or probable existence of important wildlife species or wildlife habitats in the study area. NHF&GD, NHNHI, Audubon, Southern New Hampshire Planning Commission, and the Conservation Commissions of Manchester and Salem responded.

NHF&GD responded that it knew of no important wildlife habitats such as deer yards or heron rookeries (however one was recorded during this study) within the median strip or immediately adjacent to the I-93 corridor. There are a few active beaver ponds adjacent to the highway right-of-way that provide valuable wildlife habitat for a number of species in this heavily developed area of the state. The freshwater marsh at the junction of I-293 and I-93 provides habitat for waterfowl, including birds, aquatic mammals, and amphibians.

NHNHI's response documented the occurrence of a number of state-listed rare, threatened, or endangered species in the vicinity of the study area (see Section 3.7), but mentioned no other important wildlife populations or habitats.

In addition to providing information on officially state-listed threatened and endangered species, Audubon Society provided a list of 13 wildlife species, which may occur in the study area and which they believe are of concern based on current population levels (**Table 3.6-4**). However, none of these species are officially listed as threatened or endangered.

Table 3.6-4
Wildlife Species that the Audubon Society of New Hampshire Considers of Management Concern, and Likely to Occur in the Study Area

Common Name	Scientific Name	Habitat
Jefferson Salamander	*Ambustana jeffersonianum*	Moist woodlands, swamps, wet meadows
Spotted Turtle	*Clemmys guttata*	Bogs, wet meadows, wooded streams, dry sandy uplands with exposed soil and sparse vegetation for nesting
Blanding's Turtle	*Emydoidea blandingii*	Shallow soft-bottomed ponds, swamps, marshes, dry sandy uplands to sparse vegetation for nesting
Eastern Hog-nosed Snake	*Heterodon platyrhinos*	Open woodlands with sandy soil
Least Bittern	*Ixobrychus exilis*	Deep emergent marshes
Red-shouldered Hawk	*Buteo lineatus*	Swampy woods, mature hardwoods
Sora	*Porzana carolina*	Deep, emergent marshes
Eastern Screech Owl	*Otus asio*	Open woodlands, shade trees
Whip-poor-will	*Caprimulgus vociferous*	Dry, open woods
Golden-winged Warbler	*Vermivora chrysoptera*	Brushy fields, thickets
Vesper Sparrow	*Pooecetes gramineus*	Dry open uplands
Grasshopper Sparrow	*Ammodramus savannarum*	Dry grasslands
New England Cottontail	*Sylvilagus transitionalis*	Dense, shrubby woodlands

A review of published materials including USGS topographic maps and National Wetlands Inventory Maps, NHDOT's previous work on wetlands within the I-93 right-of-way, and windshield surveys in 1992, 1993 and 1998 of the study area, indicate that a wide variety of wildlife habitats exist within the study area, including upland hardwood forests, upland softwood forests, mixed upland forests, forested (primarily red maple) wetlands, scrub-shrub wetlands, emergent marshes, wet meadows, lakes, ponds, streams, rivers, agricultural fields and pastures, "old fields" (i.e., shrublands), and recently disturbed areas.

Practically all of the wildlife habitats along the study corridor have been affected in some fashion by their proximity to the highway. Residential and commercial development is prevalent along this section of I-93, particularly in Salem and Manchester. The wildlife value of much of the existing habitat is reduced due to fragmentation (by the encroaching development and the highway itself), frequent human disturbance such as vehicular traffic, human activity (including occasional foot and ATV activity, noise, and pollution from highway and development runoff, and various other non-point sources.

The most valuable existing habitats in the study area are the riparian areas along the rivers and streams, lakes and ponds with accompanying buffer zones, and the larger wetlands (particularly the emergent wetlands). Also, any large contiguous blocks of forest, particularly those on public property or within wetlands where there is some measure of protection against development, are important study area habitats. The

Manchester Conservation Commission, as well as Federal and State natural resource agencies, consider the riparian wetland complex along Cohas Brook to be a particularly high value wetland.

3.6.4.2 Spring Field Survey - 2001

During May 9-10, 2001, the entire project corridor, from the Massachusetts/New Hampshire state line north to the I-293/I-93 split in Manchester was investigated. This spring survey was performed for the purpose of documenting wildlife corridors and wildlife habitat of concern as well as locating threatened or endangered plant and animal species. Wildlife observation stations were designated in relation to wetland systems in order to obtain an overall understanding of the existing natural resources.

A comprehensive list of wildlife species observed on May 9 and 10, 2001, is shown in Table 3.6-5. Species are listed as to the station they were located at, as well as by the way they were located (i.e., auditory or visual).

Table 3.6-5
Wildlife Species Observed During Spring 2001 Surveys

Common Name	Scientific Name	Evidence	Station Recorded
Birds			
American robin	*Turdus migratorius*	Visual/Auditory	1, 2B, 2D, 4B, 4C, 10A, 11 east, 11 west, 12, 13A
Red-winged blackbird	*Agelaius phoeniceus*	Visual/Auditory	1, 2B, 2D, 3, 4C, 6A, 6B, 8, 9A, 10A, 11 east, 11 west, 12, 13A
Phoebe	*Sayornis phoebe*	Visual/Auditory	1
American goldfinch	*Carduelis tristis*	Visual/Auditory	1, 4B, 4C, 7A, 10A, 11 east, 13A
Killdeer	*Charadrius vociferus*	Visual/Auditory	1
Pine warbler	*Dendroica pinus*	Visual/Auditory	1, 4A, 9B, 11 east
Rock Dove	*Columba llivia*	Visual	1
Tufted Titmouse	*Parus bicolor*	Visual/Auditory	1, 2, 2D, 4A, 4B
Black-capped chickadee	*Parus atricapillus*	Visual/Auditory	1, 2B, 3, 4A, 4B, 4C, 7B, 8, 13A
Common grackle	*Quiscalus quiscula*	Visual/Auditory	2B, 2D, 3, 4C, 8, 9B, 10A, 11 east, 11 west, 12, 13A, 13B
Chipping sparrow	*Spizella passerina*	Visual/Auditory	4A
Blue Jay	*Cyanocitta cristata*	Visual/Auditory	2D, 4A, 7A, 7B, 9A
Northern flicker	*Colaptes auratus*	Visual/Auditory	4C, 10A, 13A
Song sparrow	*Melospiza melodia*	Visual/Auditory	1, 2B, 2D, 4C, 6B, 7A, 8, 10A, 11 east, 12, 13A
Gray catbird	*Dumetella carolinensis*	Visual/Auditory	2B, 2D, 12, 13A
Yellow-throated warbler[1]	*Dendroica dominica*	Visual/Auditory	2B, 12, 13A

Table 3.6-5 (continued)

Common Name	Scientific Name	Evidence	Station Recorded
House finch	*Carpodacus mexicanus*	Visual/Auditory	2B, 12
Baltimore oriole	*Icterus galbula*	Visual/Auditory	2B, 4B, 8, 10A, 12
Mallard	*Anas platyrhynchos*	Visual	2B, 12, 13A, 13B
American crow	*Corvus brachyrhynchos*	Visual/Auditory	2B, 2D, 12
Canada goose	*Branta canadensis*	Visual/Auditory	2D, 6B, 7A, 10A
Cardinal	*Cardinalis cardinalis*	Visual/Auditory	2D
Northern oriole	*Icterus sp.*	Visual/Auditory	3, 4C, 13B
Spotted sandpiper	*Actitis macularia*	Visual	4C, 13
Great blue heron	*Ardea herodias*	Visual	6A, 11 east
Tree sparrow[2]	*Spizzela arborea*	Visual	6A, 8, 10A, 13B
Common yellowthroat	*Geothlypis trichas*	Visual/Auditory	7A, 13B
Black and white warbler	*Mniotilta varia*	Visual/Auditory	7B
Mourning dove	*Zenaida macroura*	Visual/Auditory	8, 10, 13A, 13B
Downy woodpecker	*Picoides pubescens*	Visual/Auditory	8
White-breasted nuthatch	*Sitta carolinensis*	Visual/Auditory	8
Tree swallow	*Tachycineta bicolor*	Visual/Auditory	13A
Rough-winged swallow	*Stelgidopteryx serripennis*	Visual/Auditory	13A
Northern mockingbird	*Mimus polyglottos*	Visual/Auditory	8, 9A, 10A
Warbling vireo	*Vireo gilvus*	Visual/Auditory	8
Amphibians			
Spring peeper	*Pseudacris crucifer*	Visual/Auditory	8, 9A
Green frog	*Rana clamitas melanota*	Visual/Auditory	2B, 3, 4B, 4C, 6C, 7B, 8, 11 east, 12
Pickerel frog	*Rana palustris*	Visual	6C
Mammals			
Raccoon	*Procyon lotor*	Tracks in mud	2B, 12, 13A
Beaver	*Castor Canadensis*	Old dams, girdled saplings, chewed tree stumps	2B, 2D, 3, 4C, 6A, 6B, 7A, 8, 9B, 10A, 11 east, 12, 13A
Otter	*Lutra canadensis*	Tracks in mud	13A
Red Fox	*Vulpes fulva*	Tracks in mud	2D
Muskrat	*Ondatra zibethicus*	Nipped sedges and cattails	6C
Eastern Cottontail	*Sylvilagus floridanus*	Visual	4B

1 Commenting on the DEIS, NH Audubon pointed out that the identification of a yellow-throated warbler was probably an error. This species would be extremely rare in New Hampshire.

2 NH Audubon also pointed out that tree sparrows occur in New Hampshire during the winter but migrate north in the spring for breeding. They suggest that the correct identification was probably a chipping sparrow (*Spizella passerina*).

3.6.4.3 Habitats and Wildlife Use

The various habitats or vegetation cover types found in the study area are described below. Habitat characteristics and location of each type determine the mix of wildlife species that will be present. Species representative of each type are given. A list of species which could potentially utilize these habitats was compiled from the NEWILD Computer Program (Thomasma *et al*. 1998) and is included in Appendix D.

Upland Types

Natural upland habitats in the study corridor include three forested communities (hardwood dominated, softwood dominated, and mixed), shrublands, grasslands including pastures and hayfields, and orchards. Although residential yards and other suburban/urban areas provide some habitat to wildlife, their value is typically low compared to natural, undisturbed areas.

Hardwood Forest

The mature hardwood forests in the study area are typically dominated by red oak and northern hardwoods (American beech, yellow birch, and sugar maple) often with a large component of softwoods (white pine and hemlock). There are usually four layers of vegetation, but only the overstory is dense. Common shrub species include witch hazel, beaked hazelnut, northern wild raisin and seedlings of red maple, American beech, white pine, hemlock, and red oak. The herbaceous layer is typically sparse consisting of Canada mayflower and several species of ferns. A litter layer comprised of leaves and dead twigs covers the ground.

Young hardwood stands, as typically found in recently cutover areas, are dominated by pioneer species like gray birch, quaking aspen and pin cherry, as well as sprouts of red oak. With the reduced canopy layer (i.e., shade) in these young stands, the herbaceous and shrub layer is usually dense.

In general, the greater the number of vegetation layers and the density of each (called structural diversity), the greater is the diversity of bird species (MacArthur and MacArthur 1961). The mature hardwood stands have a moderate level of structural diversity while the young stands slightly higher. The mature stands are characterized by bird species preferring a closed canopy (e.g., sharp-shinned hawk, barred owl, red-eyed vireo, black and white warbler, scarlet tanager), moderate size tree boles (e.g., downy woodpecker, brown creeper, white-breasted nuthatch) or a forest floor with a thick litter layer including logs and scattered patches of herbaceous cover (redback salamander, wood thrush, ovenbird). Mammals include gray fox, gray squirrel, southern flying squirrel, eastern chipmunk, and white-footed mouse. In comparison, the young stands are characterized by species more commonly associated with early successional stages like shrublands (e.g., ruffed grouse, American redstart, chestnut-sided warbler, willow flycatcher, eastern cottontail, white-footed mouse, short-tailed shrew). White-tailed deer browse in both mature and young hardwood stands. Wild turkeys also forage in both age classes.

Softwood Forest

Areas of softwood forest are dominated by either white pine or hemlock. Structural diversity is typically low to moderate. The dense shading results in an undeveloped shrub and herbaceous layer. The litter layer is characterized by needles and dead branches, leading to a highly acidic environment that also inhibits herbaceous growth.

Although softwood stands typically serve as deer wintering areas (because of the protection they afford from winds and low temperatures), their proximity in the study area to human development and the highway itself preclude them from serving this function. Other species typically associated with softwood forests include red squirrel, porcupine, black-capped chickadee, veery, and blackburnian warbler.

Mixed Forest

The largest forested stands in the study area are typically mixed forest and composed of species found in both hardwood and softwood types. Structural diversity varies from moderately low to moderately high. Structurally these mixed stands are similar to hardwood stands and contain many of the same wildlife species (veery, rose-breasted grosbeak, red-backed salamander, eastern chipmunk, and gray squirrel).

Shrubland

Shrubland in the study area includes primarily “old fields" reverting to young forest. Old fields are classified as shrubland when they contain a shrub layer of at least 30 percent coverage with the remainder dominated by dense grasses and forbs.

Bird species typically associated with shrublands include chestnut sided warbler, common yellowthroat, rufous-sided towhee, prairie warbler, American goldfinch, field sparrow, and song sparrow. Common mammal species include white-footed mouse, short-tailed shrew, red fox, and eastern cottontail.

Grassland/Agricultural Field

This habitat type includes both pastures and mowed fields, as well as the mowed right-of-way edge of the highway. Structural diversity is characteristically low with the mowing diminishing both the cover and food value of the habitat. Nonetheless the edge created between this and other more mature forested areas is very valuable. Species typical of this habitat and its edge include red-tailed hawk, eastern meadowlark, American robin, American goldfinch, song sparrow, yellow warbler, woodchuck, meadow vole, eastern cottontail, and red fox. In hot summer nights, white-tailed deer will also be seen grazing in open fields where they can escape forest insects.

Orchard

Orchards are a habitat type closely related to grasslands because of their evenly spaced trees and the mowed herbaceous layer. The historic Woodmont orchard along

the west side of I-93 north of Exit 4 is particularly impressive. Species representative of this type are typically a mix of those found in grasslands and young forests (e.g., American kestrel, rose-breasted grosbeak, Baltimore oriole, eastern kingbird, woodchuck, meadow vole, short-tailed shrew, and red fox).

Wetland Types

Wetlands are a particularly important habitat for wildlife (see Section 3.6.3.2). All amphibians require water or wet areas for breeding so their occurrence is dependent on wetlands. Vernal pools provide essential breeding habitat for mole salamanders (Genus *Ambystoma*) as well as wood frogs (see Section 3.6.3.3). Many reptile species also depend on wetlands.

Described below are the major wetland types found in the study area along with representative species of each.

Forested Wetlands (Forested Swamps)

Forested wetlands in the study area are typically dominated by red maples with varying amounts of hemlock, white pine, spruce and balsam fir intermixed. The typical interspersion of water and trees creates high structural diversity that enhances this habitat's value for wildlife. Common species include a variety of amphibians (spring peeper, gray treefrog, wood frog, bullfrog, green frog, mole salamanders) and reptiles (eastern ribbon snake, ringneck snake, painted turtle, snapping turtle).

The avian community found in red maple swamps is typically composed of facultative species, those which are found in upland forests as well, e.g., black-capped chicadee, gray catbird, ovenbird, wood thrush, American robin and blue jay; (Golet *et al*. 1993). Other bird species appear to be attracted to this habitat because of the presence of water, e.g., wood duck, American black duck, and mallard. Bird species perhaps most characteristic of forested wetlands of the northeast include northern waterthrush, Canada warbler, and veery (Golet *et al*. 1993). Among raptors, red-shouldered hawks are probably most characteristic of forested wetlands where they both nest and hunt. Characteristic mammalian species include beaver, raccoon, mink, woodland jumping mouse, and white-footed mouse.

Scrub-Shrub Swamp

Scrub-shrub swamps in the study area are dominated by species like highbush blueberry, willow, alder, dogwood, and northern arrowwood. Structural diversity is low because of the lack of multiple vegetation layers. Nonetheless there is typically dense shrub growth, along with dense herbaceous growth in spots. Seasonally this habitat (like forested wetlands) is frequently flooded by an adjacent stream or runoff from surrounding uplands.

Amphibians and reptiles commonly found in shrub swamps include spring peepers and wood frogs, while the presence of open water enhances the attraction for snapping turtles and painted turtles. Bird species commonly found in this habitat include American woodcock, song sparrow, alder flycatcher, and tree swallow. Mammalian species include white-footed mouse, meadow jumping mouse, and raccoon.

Emergent Marsh

There are generally two types of emergent marshes in the study area: shallow marshes with water depths up to 1.5 feet characterized by persistent vegetation such as cattails, pickerel weed, and two common invasive species, purple loosestrife and phragmites; and deep marshes with water depths up to 6.0 feet characterized by emergent vegetation such as cattails, pickerel weed, and floating-leaved plants like pond lily, yellow water lily, and water shield. Frequently "wet meadows" or "sedge meadows" are included in the shallow marsh category. These meadows will have up to 6 inches of water in winter or early spring, but with an exposed, saturated soil surface in summer (Thomasma *et al*. 1998).

Typical species found in marshes include mallard, sora rail, American bittern, great blue heron, red-winged blackbird, muskrat, foraging white-tailed deer, and common snapping turtle. During the dry summer months, meadow vole, meadow jumping mouse and American kestrel will be observed in shallow marshes and sedge meadows.

Open Water (Ponds & Lakes)

There are three large lakes or ponds in the study area: Canobie Lake, Cobbetts Pond, and Crystal Lake. Characteristics and the water quality classification of each are described under Surface Water Resources, Section 3.4.1. Two additional large ponds are Wheeler Pond at Exit 4 and an unnamed pond (identified as Exit 5 pond) and marsh along the eastside of I-93 just north of Exit 5.

Wildlife use of these open-waterbodies is largely a reflection of the surrounding or bordering habitats. The margins of the lakes and ponds contain areas of either deep or shallow marsh, while in other areas, lake-front homes or woodlands line their edge.

Wildlife representative of ponds and lakes include bull frog, pickerel frog, painted turtle, common loon, hooded merganser, common merganser, mallard, Canada goose, beaver, otter, and mink.

3.6.4.4 Important Wildlife Habitats

Some of the habitats in the study area are particularly important to wildlife. These include seven confirmed vernal pools; several known locations of threatened or endangered species; three large riparian corridors, and a heron rookery. Vernal pools are described in detail under Wetland Resources in Section 3.6.3.3. Threatened and

endangered species are addressed separately in Section 3.7 because of their special protection status.

Riparian Corridors

All the perennial streams crossed by the 19.8-mile segment of I-93 have riparian corridors associated with them. Most of these are already severed to some extent by the highway. Wildlife passage through culverts or under bridges is dependent on the width of the opening, length of culvert, and of course the size of the particular species, i.e., white-tailed deer and moose may be forced to cross over the highway rather than under it. Particularly important stream crossings, because of their size and expanse, include Cohas Brook, Beaver Brook, and Porcupine Brook. An extensive riparian corridor lies along the Spicket River, although this river is not crossed by I-93 in New Hampshire.

Heron Rookeries

In their 1992 letter, Audubon reported that three active great blue heron (*Ardea herodias*) rookeries occur within south central New Hampshire, but indicated they are outside the project's influence. During the July 1998 field review, field biologists noted an active rookery with three active great blue heron nests located west of the highway in Wetland System 14, approximately 1,500 feet south of the southbound weigh station in Windham.

3.6.4.5 Wildlife Refuges

There are no publicly or privately-owned wildlife refuges within the study area.

3.7 Threatened and Endangered Species

Federal Regulatory Protection

The Endangered Species Act of 1973 (“ESA”) (P.L. 93-205), as amended in 1973 and 1978, recognizes the need, and provides the means to protect rare plants, invertebrates and vertebrate species of fish and wildlife, and provides for the protection and/or acquisition of critical habitats and the management of endangered species. Per the 1978 Amendments to the ESA, separate (geographically or genetically isolated) but rare populations of fish and wildlife (but not plants or invertebrates) may be protected as well as entire species. Listed species are categorized as either endangered species (which are in danger of extinction throughout all or a substantial portion of its ranges) or threatened species (which are likely to become endangered throughout all or a substantial portion of its range).

Section 7 of the ESA dictates that all federal agencies must consult the U.S. Fish and Wildlife Service (USFWS) to ensure that actions taken under federal funding, federal

assistance, or federal permits (e.g. Section 404 Army Corps Permits) do not jeopardize the existence of threatened or endangered species. Jurisdiction is given to the USFWS to recommend changes to the project to avoid such jeopardy (including impacts to the habitat as well as to the plants or animals themselves).

State Regulatory Protection

In New Hampshire, the Endangered Species Conservation Act (RSA 212-A) delegates authority and responsibility for the listing and protection of threatened and endangered species of wildlife to the NHF&GD. This statute outlines NHF&GD authority and direct other state agencies to take reasonable steps to insure their actions do not jeopardize the continued existence of threatened or endangered species or result in the destruction or modification of their critical habitat. NHF&GD has in turn promulgated the rules for the protection of these species in Fish and Game Rules, Conservation of Endangered Species. Species eligible for listing under these rules include invertebrates and vertebrate species of fish and wildlife (plants are not included). Protected animal species are placed in one of two categories, threatened or endangered, depending on their rarity.

NHF&GD manages threatened and endangered species cooperatively with the New Hampshire Natural Heritage Inventory (NHNHI). The NHNHI has compiled information on the distribution and abundance of these species from the literature, from files of area scientists, and from various field surveys, into computerized databases. These databases provide information on the present, past, or probable existence of such species for improved land use planning and environmental impact assessment.

The New Hampshire Native Plant Protection Act RSA 217-A, enacted by the State Legislature in 1987, established the authority for the state to develop a list of rare plant species. The NHNHI was empowered with this authority and developed the list in NH Administrative Rules Chapter Res 1100. Plants deemed as rare in the State and in need of protection were listed as either endangered, threatened, or special concern plant species in descending order of rarity.

Unlike federally listed species, plant or wildlife species need only be rare within the State of New Hampshire to be state-listed, not rare over the entire range of the species. Therefore, many state-listed species are rare because New Hampshire is at the edge of their range, or because there is a limited amount of habitat for the species within the state. Legal protection is also much less stringent in state statutes. Besides the prohibitions on the taking or killing of state-listed wildlife species, protection of state listed plants or animals is largely restricted to recommendations by the aforementioned state agencies for the approval or disapproval of projects which might impact the environment. All projects initiated or funded by the state, or applying for such state permits as Wetlands Dredge and Fill Permits, or Site Specific Permits, are forwarded to NHF&GD and NHNHI, which have the opportunity to recommend approval or denial.

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3.7.1 Plants

3.7.1.1 Federal Threatened and Endangered Plant Species

No federally listed threatened or endangered plant species are known to occur in or near the project area.

3.7.1.2 State Rare, Threatened and Endangered Plant Species

There are four populations of state-threatened or endangered plant species with documented occurrence in the vicinity of the I-93 corridor as of June 2002. (See Table 3.7-1.) Based on mapped information provided by the NHNHI and supplemented by field work conducted during the project development, only one population is known to occur in close proximity to the proposed project: a population of wild lupine (*Lupinus perennis*) found on the west side of the project corridor just south of Exit 2 in Salem.

Table 3.7-1
State-Listed Threatened and Endangered Plant and Animal Species in the Project Vicinity

Scientific Name	Common Name	Ranks		Status	Location	Last Observed
Animal Species						
Heterodon platyrhinos	Eastern hog-nose snake	S2	G5	ST	Manchester Bricket Rd/ I-93	1977
Plant Species						
Arethusa bulbosa	Arethusa	S1	G4	SE	Windham Depot	1909 (Historical)
Lupinus perennis	Wild lupine	S1	G5	ST	Between Exits 1 and 2 on west side of I-93	1985
Rhododendron viscosum	Swamp azalea	S2	G5	ST	Southeast of Exit 1	1957 (Historical)
Rhododendron viscosum	Swamp azalea	S2	G5	ST	Northeast of Exit 2, South of NH 38	1958 (Historical)

Ranks: **S1** = Critically imperiled in state because of extreme rarity.
S2 = Imperiled in state because of rarity (6-20 occurrences).
G4 = Apparently secure globally but may be rare in parts of range.
G5 = Demonstrably secure globally but may be rare in parts of range.

Status: **SE** = State Endangered.
ST = State Threatened.

Note: These data are from a database check for reported occurrences conducted by the NHNHI in 2002.
"Historical" records are those occurrences for which a population was once observed, but has not been recovered for a long duration. They are not normally a concern from the viewpoint of the NH Natural Heritage Inventory.

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3.7.2 Wildlife

3.7.2.1 Federal Threatened and Endangered Wildlife Species

According to the USFWS, bald eagles *(Haliaeetus leucocephalus)* have established a nest along the Merrimack River in the Manchester/Bedford area. Additionally, each winter, several bald eagles can be found along the Merrimack River from Franklin south to the Massachusetts line, where they hunt in ice-free areas of the River. Based on their review of the project, however, the USFWS expressed the opinion that the I-93 project would have no direct effects on eagles (M. Bartlett, USFWS, letter dated June 12, 2002; Appendix E).

The New England cottontail *(Sylvilagus transitionalis)* is a species for which the USFWS is considering federal listing. The habitat for this species is early successional or shrub-dominated habitats, which include old fields, brushy areas, open woodlands, and recent clear cuts. Although the species has not been directly observed during field work associated with this project, these habitat types are present in the project corridor. Due to the limited understanding of the distribution of this species in the project area, the USFWS recommended that its presence/absence be determined for the study area (M. Bartlett, USFWS, letter dated June 12, 2002; Appendix E).

In coordination with the USFWS, a survey was conducted during the winter and spring of 2003 to examine the distribution and abundance of New England cottontails and their habitat within the I-93 study corridor (Litvaitis, *et al.* 2003). This study included an intensive search for all suitable habitat along the existing 19.8-mile corridor. For each habitat patch, cottontail presence was evaluated using track inventories, livetraps and DNA analysis of fecal pellets. A total of 35 sites were evaluated, including all 11 sites proposed as mitigation at that time.

The study found that the area immediately adjacent to I-93 contains few sites that are suitable habitat for New England cottontail. No New England cottontails were found on any of the sites along the project corridor and mitigation sites, although the more common eastern cottontail was found on three mitigation sites. New England cottontails were found on one site located north of the project area. Table 3.7-2 contains a listing of the sites examined during this field study.

3.7.2.2 State Threatened and Endangered Wildlife Species

There is only one state-threatened or endangered wildlife species (eastern hognose snake) with a recorded occurrence in the vicinity of the project area (Table 3.7-1). A

single documented observation of the eastern hognose was recorded in the extreme northeastern portion of the study area.

Table 3.7-2
Summary of Sites Searched for New England Cottontails (NEC) and Eastern Cottontails (EC) Along the I-93 Project Corridor and Proposed Mitigation Lands. (After Litvaitis *et al.* 2003)

Site[1]	Latitude	Longitude	Description	Species
058	N42°57'15.1"	W71°24'48.6"	Mitigation Site #43: >5 acres, poor lagomorph habitat: pole stand with little ground cover	Vacant
059	N42°56'54.9"	W71°24'1.5"	Mitigation Site #47: >5 acres, large site with limited understory cover	Vacant
060	N42°58'1.0"	W71°24'56.8"	Just north of project area: >5 acres, abundant understory vegetation	NEC
061	N42°56'47.0"	W71°24'28.2"	Mitigation Site #46: >5 acres, mid-successional forest with little understory vegetation	Vacant
062	N42°57'5.6"	W71°24'55.7"	Mitigation Site #53: >5 acres, suitable habitat with abundant understory vegetation	Vacant
063	N42°56'52.6"	W71°24'45.3"	Mitigation Site #3: site under construction with little suitable habitat	Vacant
064	N42°57'18.9"	W71°24'9.1"	Mitigation Site #2: >5 acres, little suitable habitat, surrounded by suburban development	Vacant
065	N42°51'1.6"	W71°20'25.7"	Mitigation Site #15: >5 acres, suitable habitat with abundant canid tracks	Vacant
066	N42°50'57.5"	W71°20'20.2"	Mitigation Site #14: <5 acres, poor lagomorph habitat with little understory vegetation	Vacant
067	N42°51'5.4"	W71°18'18.3"	Mitigation Site #16: >5 acres, mix of habitats, most forested with little understory	Vacant
068	N42°49'41.0"	W71°18'1.0"	Not part of project area, near Site 67, checked because residents indicated rabbits were present	EC
069	N42°50'39.2"	W71°18'8.6"	Not part of project, near Site 67, <5 acres, dense understory vegetation	Vacant
070	N42°55'32.9"	W71°22'0.3"	Mitigation Site #7: >5 acres. Tree farm with little understory vegetation	Vacant
071	N42°55'8.3"	W71°21'56.1"	Wetland portion of VHB Mitigation Site #7: <5 acres, ample understory vegetation but small	Vacant
072	N42°48'36.3"	W71°15'23.5"	Mitigation Site #55: >5 acres, wooded with little understory vegetation	Vacant
073	N42°48'6.2"	W71°16'29.0"	Mitigation Site #49: <5 acres, wooded with sparse understory vegetation. Old tracks but no pellets found. Transient cottontail?	Vacant
074	N42°48'0.8"	W71°16'1.1"	Mitigation Site #24 (portion on east side of I-93, not median portion): <5 acres, wetland with narrow strip of suitable habitat (~50 x 400 ft).	EC
075	N42°54'6.3"	W71°21'33.8"	Mitigation Site #59: open wetland surrounded by closed-canopy forest	Vacant
076	N42°46.4'7"	W71°16'24.1"	Mitigation Site #31: <5 acres, open, boggy wetland	Vacant
077	N42°46'23.4"	W71°14'47.5"	Mitigation Site #35: <5 acres, open, boggy wetland	Vacant
078	N42°45'54.7"	W71°14'5.8"	Mitigation Site #38: <5 acres, pond surrounded by forest	Vacant
079	N42°45'43.7"	W71°13'18.1"	Mitigation Site #30: <5 acres, wetland with limited cover, sandwiched between developments	Vacant
080	N42°45'29.4"	W71°13'33.2"	Mitigation Site #36: >5 acres, closed-canopy forest surrounded by open field	Vacant
081	N42°44'40.5"	W71°12'25.2"	Mitigation Site #33 (North): >5 acres, old-field with scattered ponds and brook	EC
082	N42°44'58.8"	W71°12'33.2"	Mitigation Site #33 (South): >5 acres, heavy disturbance with small patches of suitable habitat	EC
083	N42°48'2.4"	W71°14'43.9"	Mitigation Site #32:>5 acres, closed-canopy woods with open field, limited understory vegetation	Vacant
084	N42°54'56.9"	W71°22'7.3"	I-93 Exit 5 (mile marker 15.2 on I-93N): <5 acres, marginal habitat with limited cover	Vacant
085	N42°51'37.1"	W71°19'39.2"	Mile marker 9.6 on I-93 N (access at Kendall Pond Road): >5 acres, large wetland with pockets of suitable understory vegetation	Vacant
086	N42°49'28.6"	W71°17'20.9"	Truck weigh station on I-93 N: >5 acres, sparse understory vegetation	Vacant
087	N42°51'22.0"	W71°19.3'6"	Mile marker 8.6-9.1 on I-93 N: >5 acres, sparse cover	Vacant
088	N42°52'50.6"	W71°20'44.3"	I-93 Exit 4 (mile marker 11.9 on I-93 S): <5 acres, wetland with good cover, but small area	Vacant
089	N42°51'38.5"	W71°20'83.5"	NHDOT Maintenance Facility on I-93 S: >5 acres, patches of good habitat	Vacant
090	N42°48'30.2"	W71°17'72.8"	Truck weigh station on I-93 S: >5 acres, marginal habitat (sparse understory)	Vacant
179	N42°53'41.9"	W71°21'35.4"	Powerline corridor on I-93 S: >5 acres limited understory	Vacant
180	N42°56'53.7"	W71°23'41.8"	Mile marker 17.8 on I-93 N: <5 acres, wetland with patches of suitable habitat	Vacant

1. Site numbers are located in Litvaitis et al. (2003)

Michener and Lazell (1989) describe hognose distribution in eastern New England, indicating that disjunct populations of the snake occur in pine barren and white pine habitat in the Merrimack River drainage. Oberkrieser and Litvaitis (2002) conducted field studies of the eastern hognose in the Merrimack Valley of New Hampshire, which is considered to be the northern extent of the species' range in the northeast. Their field study of six suitable habitats in Litchfield, Londonderry and Nashua did not discover any individuals of this species, which Oberkreiser and Litvaitis (2002) interpreted as evidence that the snake may be even rarer than previously thought. Consultation with the NHF&GD suggests that field surveys for the hognose may be difficult due to the snake's rarity and behavior. Despite the fact that previous efforts to study the New Hampshire eastern hognose populations have been limited in success, the NHF&GD has received four reports of likely sightings of the snake in the Merrimack River corridor in 2003, suggesting that the viable populations of the snake are still present in the vicinity (John Kanter, personal communication).

Based on comments and coordination with the NHF&GD since publication of the DEIS, populations of, and habitat for, the eastern hognose snake may occur within the project corridor. Further investigation of potential habitat and the presence of this species will be performed during final design in cooperation with the NHF&GD.

In addition to the previous NHNHI list of documented occurrences of state-listed species in the study area, the Audubon Society of New Hampshire (Audubon) expressed concern about the following 12 wildlife species that they characterized as having a "high potential of occurrence" in the study area:

- The Pied-billed Grebe (*Podolymbus podiceps*), is a small diving bird, that typically breeds/nests in emergent/open water wetlands of at least 50 acres, and uses lakes, ponds, and rivers. Substantial amounts of emergent wetlands and surface waters exist within and near the study area and may provide habitat for this species. However, NHNHI has not documented this species in the study area.

- The state-listed endangered Upland Sandpiper (*Bartramia longicauda*) has had a nesting population as recently as 1984 at the Manchester Airport. This shorebird nests in wide open habitat such as airports, pastures, and hayfields. However, NHNHI has not documented this species in the study area.

- The Merrimack River within Manchester and Londonderry constitutes a major portion of New Hampshire's primary bald eagle (*Haliaeetus leucocephalus*) wintering area; however, Audubon expressed the opinion that the project would have no impact on bald eagles or their habitat and the USFWS and the NHF&GD have not identified their presence in the project area.

- The Sedge Wren (*Cistithorus platensis*), a small state-listed endangered species, uses emergent marshes and sedge meadows during breeding and migrating seasons. However, NHNHI has not documented this species in the study area.

- Henslow's Sparrow (*Ammodramus henslowii*) is a small, state-listed endangered species that breeds in wet meadows and moist, weedy fields. However, NHNHI has not documented this species in the study area.

- According to Audubon, the Brook Floater (*Alasmidonta varicosa*), a state-listed endangered species of mollusk is known to occur in the Merrimack River in Manchester. However, Audubon assumed the project would have no impact on the species unless it precipitated a siltation event far downstream in the Merrimack River.

- The Common Loon (*Gavia immer*), a state-listed threatened species, is known to nest at Massabesic Lake in Manchester. However, Audubon felt it unlikely that the project would impact this species.

- According to Audubon, the Northern Harrier (*Circus cyaneus*), a large, state-listed threatened species of hawk has been reported from Derry, Londonderry, and Manchester in the past decade. However, the Society felt it unlikely that the project could impact this species which forages over large open fields, pastures, and marshes.

- The Osprey (*Pandion haliaetus*), a large piscivorous raptor (state-listed threatened) is known to forage in the Merrimack River, in ponds of all sizes, and in wetlands with open water in the area during migration. However, Audubon felt it unlikely that the project would impact the species.

- Audubon indicated that downtown Manchester supports one of the state's largest populations of Common Night Hawks (*Chordeiles minor*), a state-listed threatened species which commonly nests on flat graveled roof tops. Again Audubon felt the project would have no impact on this species.

- The Purple Martin (*Progne subis*), a state-listed threatened bird species, typically nests in man-made birdhouses adjacent to extensive open fields and water. Audubon related that sightings were made in Manchester in 1982, but that the project is unlikely to affect this species.

- The Cooper's Hawk (*Accipiter cooperii*) is a small bird-eating hawk that is state-listed as threatened. Sightings have been made of this bird in Manchester (in the last 10 years) and Windham (in the 1970's). The Cooper's Hawk nests in deciduous and mixed forests. These habitats are found within the study area. However, NHNHI has not documented this species in the study area.

3.8 Noise Environment

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3.8.1 Introduction

The NHDOT[29] and FHWA[30] noise impact assessment procedures for Type I projects were used to identify receptor locations, to predict existing and future highway noise levels, to determine project noise impacts, and to evaluate noise mitigation measures in the I-93 (Salem to Manchester) improvement project area. A Type I project is a highway project that results in the construction of a new highway or the physical alteration of an existing highway that substantially changes either the horizontal or vertical alignment or increases the number of through travel lanes.

Noise is defined as unwanted or excessive sound. Sound becomes unwanted when it interferes with normal activities such as sleep, work, or recreation. The individual human response to noise is subject to considerable variability since there are many emotional and physical factors that contribute to the differences in reaction to noise.

Sound (noise) is described in terms of loudness, frequency, and duration. Loudness is the sound pressure level measured on a logarithmic scale in units of decibels (dB). For community noise impact assessment, sound level frequency characteristics are based upon human hearing, using an A-weighted (dBA) frequency filter. The A-weighted filter is used because it approximates the way humans hear sound. Table 3.8-1 presents a list of common indoor and outdoor sound levels. The duration characteristics of sound account for the time-varying nature of sound sources.

The most common way to account for the time-varying nature of sound (duration) is through the equivalent sound level measurement, referred to as L_{eq}. The L_{eq} averages the background sound levels with short-term transient sound levels and provides a uniform method for comparing sound levels that vary over time. The time period used for highway noise analysis is typically one hour. The peak hour L_{eq} represents the noisiest hour of the day/night and usually occurs during the peak periods of automobile and truck traffic. The FHWA guidelines and criteria require the use of the one-hour L_{eq} for assessing highway noise impacts on different land uses.

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29 *Policy and Procedural Guidelines for the Assessment and Abatement of Highway Traffic Noise for Type I Highway Projects*, New Hampshire Department of Transportation, July 1996.

30 *Procedures for Abatement of Highway Traffic Noise and Construction Noise*, Federal Highway Administration's Title 23 Code of Federal Regulations, Part 772.

Table 3.8-1
Indoor and Outdoor Sound Levels

Outdoor Sound Levels	Sound Pressure (μPa)		Sound Level (dBA)	Indoor Sound Levels
	3,324,555	-	110	Rock Band at 5 m
Jet Over-Flight at 300 m		-	105	
	2,000,000	-	100	Inside New York Subway Train
Gas Lawn Mower at 1 m		-	95	
	632,456	-	90	Food Blender at 1 m
Diesel Truck at 15 m		-	85	
Noisy Urban Area—Daytime	200,000	-	80	Garbage Disposal at 1 m
		-	75	Shouting at 1 m
Gas Lawn Mower at 30 m	63,246	-	70	Vacuum Cleaner at 3 m
Suburban Commercial Area		-	65	Normal Speech at 1 m
	20,000	-	60	
Quiet Urban Area—Daytime		-	55	Quiet Conversation at 1 m
	6,325	-	50	Dishwasher Next Room
Quiet Urban Area—Nighttime		-	45	
	2,000	-	40	Empty Theater or Library
Quiet Suburb—Nighttime		-	35	
	632	-	30	Quiet Bedroom at Night
Quiet Rural Area—Nighttime		-	25	Empty Concert Hall
Rustling Leaves	200	-	20	
		-	15	Broadcast and Recording Studios
	63	-	10	
		-	5	
Reference Pressure Level	20	-	0	Threshold of Hearing

Source: Highway Noise Fundamentals, Federal Highway Administration, September 1980.
μPA MicroPascals describe pressure. The pressure level is what sound level monitors measure.
DBA A-weighted decibels describe pressure logarithmically with respect to 20 μPa (the reference pressure level).

The following general relationships exist between hourly traffic noise levels and human perception:

- A 1 or 2 dBA increase/decrease is not perceptible to the average person.
- A 3 dBA increase/decrease is a doubling/halving of acoustic energy, but is just barely perceptible to the human ear.
- A 10 dBA increase/decrease is a tenfold increase/decrease in acoustic energy, but is perceived as a doubling/halving in loudness to the average person.

The FHWA has established noise abatement criteria[31] to help protect the public health and welfare from excessive vehicle traffic noise. Traffic noise can adversely affect human activities such as communication. Recognizing that different areas are sensitive to noise in different ways, the FHWA has established Noise Abatement Criteria (NAC) according to land use. The NAC are described in Table 3.8-2. The NHDOT and FHWA consider a receptor location to be impacted by noise when existing or future sound levels approach (within 1 dBA), are at, or exceed the NAC, or when future sound levels exceed existing sound levels by 15 dBA or more. It is generally considered that a 0-5 dBA increase/ decrease represents a slight change in noise levels, a 6-14 dBA increase/decrease represents a moderate change in noise levels, and a 15 dBA or greater increase/decrease represents a substantial change in noise level. The feasibility of noise mitigation is evaluated when noise impacts are identified at receptor locations.

Table 3.8-2
Noise Abatement Criteria (NAC)
One-Hour, A-Weighted Sound Levels in Decibels (dBA)

Activity Category	$L_{eq}(h)$[1]	Description of Activity Category
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purposes.
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	--	Undeveloped lands
E	52 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

Source: 23 CFR Part 772 - *Procedures for Abatement of Highway Traffic Noise and Construction Noise.*
[1] $L_{eq}(h)$ is a energy-averaged, one-hour, A-weighted sound level in decibels (dBA).

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3.8.2 Methodology

The noise analysis evaluated the highest noise levels in the study area. The highest noise levels were found to occur during the evening peak hour traffic commuting period for receptor locations adjacent to the northbound lanes of I-93 and during the morning peak hour traffic commuting period for receptor locations adjacent to the southbound lanes of I-93. The determination was based upon a review of hourly traffic data and noise monitoring data, which was conducted during peak and off-peak traffic periods along I-93. A noise monitoring program measured existing

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[31] *Procedures for Abatement of Highway Traffic Noise and Construction Noise*, Federal Highway Administration's Title 23 Code of Federal Regulations, Part 772.

peak hour sound levels at nineteen receptor locations within the study area to help establish existing sound levels and to calibrate the noise model to the specific roadway locations. The sound levels were calculated using the FHWA's approved Traffic Noise Model (TNM)[32]. The modeling input data included peak hour traffic volumes, truck mix, vehicle speeds, and roadway and receptor geometry. The existing and future sound level predictions were based on the appropriate receptor peak hour traffic commuting period. The noise analysis calculated the sound levels at receptor locations and compared the results to the NHDOT and FHWA noise impact criteria. Where noise impacts were identified, mitigation measures were evaluated to determine if they were reasonable and feasible.

The study area was evaluated to identify receptor sites that have outdoor activities that might be sensitive to highway noise. In evaluating the I-93 corridor, the study area was subdivided into approximately 30 locations containing receptor sites that are sensitive to highway noise. Within the subdivisions, approximately 1,000 receptor sites were identified along the existing I-93 corridor from Salem to Manchester. Table 3.8-3 presents the receptor locations. The receptor locations, which predominately included outdoor ground level areas between the roadways and the buildings, are shown in **Figures 3.8-1 to 3.8-23**. Most of the receptor locations (residences) fall into the FHWA's "Activity Category B", which has a noise abatement criterion of 67 dBA. Other land uses, such as commercial buildings, (i.e., those that do not involve temporary overnight residence), are in FHWA "Activity Category C" which has a noise abatement criterion of 72 dBA.

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3.8.3 Existing Conditions

Sound Level Measurements

A sound level program was conducted to obtain a sampling of the existing sound levels in the I-93 corridor and to provide a database for calibrating the noise model. The noise monitoring was conducted at nineteen receptor locations, typically residences, from March to December of 2001. These noise measurements were collected in conformance with the FHWA noise monitoring guidelines[33]. Traffic data were obtained at the same time as the sound level data. This traffic data included traffic volumes, vehicle mix (automobiles, medium trucks, and heavy trucks), and operating speeds. Noise sources in the study area included vehicles on I-93 and vehicles on local roadways. **Figures 3.8-1 to 3.8-23** presents the location of the noise monitoring sites. Table 3.8-4 presents the results of the noise monitoring program and the predicted results from the TNM. Little to no difference between the monitored results and the predicted results confirms that the Traffic Noise Model has been calibrated properly.

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[32] *FHWA* Traffic *Noise Model - Version 1.1*, US Department of Transportation, FHWA -PD-96-009, September 2000.

[33] *Measurement of Highway-Related Noise*, US Department of Transportation, Federal Highway Administration, FHWA-PD-96-046, May 1996.

Table 3.8-3
Receptor Locations

Receptor Location Number	Receptor Location	Number of Receptor Sites Represented
Location 1	Hanson Avenue. – Salem	120
Location 2	Valeska Lane. – Salem	50
Location 3	Cross Street. – Salem	35
Location 4	McLarnon Road – Salem	110
Location 5	Woodland Terrace – Salem	25
Location 6	Lowell Road – Salem	70
Location 7	Brookdale Road – Salem	25
Location 8	May Lane Drive – Salem	40
Location 9	South Shore Road – Windham	14
Location 10	Squire Armour Road – Windham	16
Location 11	Wildwood Road – Windham	25
Location 12	NH 111A – Windham	13
Location 13	West Shore Road – Windham	5
Location 13 Center	Between I-93 travel lanes – Windham	2
Location 14 East	Gov. Dinsmore Road – Windham	23
Location 14	Country Road – Windham	27
Location 15	Morrison Road – Windham	16
Location 16	Spinnaker Drive – Derry	45
Location 17	Tracy Drive – Derry	20
Location 18	Fordway Extension – Derry	20
Location 19	Mathew Drive – Derry	80
Location 20	Charleston Avenue – Londonderry	40
Location 21	Reo Lane – Londonderry	5
Location 22	Ash Street – Londonderry	10
Location 23	Trolley Car Lane – Londonderry	35
Location 24	Seasons Lane – Londonderry	22
Location 25	Rockingham Road – Londonderry	27
Location 26	Perkins Road – Londonderry	5
Location 27	Newton's Meadow Way – Manchester	51
Location 28	Bodwell Road – Manchester	40
Location 29	Cohas Avenue – Manchester	35
	Totals	1051

Source: VHB, Inc.

Table 3.8-4
Noise Monitoring Data

Receptor Location Number	Monitoring Site[1]	Monitored[3]	Predicted[3]	Difference[3]
Location 1	Hanson Avenue – Salem	71[2]	72[2]	+1
Location 2	Valeska Lane – Salem	66[2]	64	-2
Location 4	MacGregor Street – Salem	64	63	+1
Location 8	Jewell Drive – Salem	64	64	0
Location 9	South Shore Road – Windham	74[2]	72[2]	-2
Location 11	Wildwood Road – Windham	71[2]	68[2]	-3
Location 12	Locust Road – Windham	66[2]	66[2]	0
Location 12	Armstrong Road – Windham	55	57	+2
Location 14	Jackman Ridge Road - Windham	57	59	+2
Location 16	Spinnaker Drive – Derry	59	60	+1
Location 17	Tracy Drive – Derry	63	63	0
Location 19	Friar Tuck Lane – Derry	60	59	-1
Location 20	Charleston Avenue – Londonderry	68[2]	66[2]	-2
Location 23	Trolley Car Lane - Londonderry	61	62	+1
Location 24	Seasons Lane – Londonderry	65	64	-1
Location 25	Rockingham Road - Londonderry	60	57	-3
Location 27	Newton's Meadow Way - Manchester	71[2]	70[2]	-1
Location 27	Bodwell Road – Manchester	64	62	-2
Location 28	Pahray Lane – Manchester	58	58	0

Source: VHB, Inc.
[1] The monitoring sites are depicted in **Figures 3.8-1 to 3.8-23**.
[2] The sound level approaches is at or exceeds the FHWA noise abatement criterion.
[3] A-Weighted Sound Level in Decibels (dBA)

Existing Sound Levels

The existing sound levels for the study area were calculated using the TNM that was calibrated based upon the noise monitoring data. The results presented in Table 3.8-5 represent the highest sound levels in the study area that have been calculated using the existing peak hour traffic data. The study area includes a diversity of building types, such as, residential, commercial, and public buildings. The results of the noise analysis demonstrate that a majority of receptor locations currently experience sound levels that approach, are at, or exceed the NAC.

Table 3.8-5
Existing Sound Levels (dBA)

Receptor Location[1] Number	Receptor Type	Receptor Location	Existing Sound Levels
Location 1	Residential	Hanson Avenue – Salem	61 to 71
Location 2	Residential	Valeska Lane – Salem	56 to 70
Location 3	Residential	Cross Street – Salem	62 to 68
Location 4	Residential	McLarnon Road – Salem	59 to 66
	Commercial	Cross Street – Salem	64 to 68
Location 5	Residential	Woodland Terrace – Salem	58 to 67
	Commercial	S. Policy St / Raymond Ave – Salem	56 to 67
Location 6	Residential	Lowell Road - Salem	60 to 68
	Commercial	Keewaydin Drive – Salem	57 to 66
Location 7	Residential	Brookdale Road – Salem	60 to 70
Location 8	Residential	May Lane Drive – Salem	59 to 67
	Commercial	Manor / Industrial Parkway – Salem	54 to 68
Location 9	Residential	South Shore Road – Windham	66 to 70
Location 10	Residential	Squire Armour Road – Windham	48 to 65
Location 11A	Residential	Wildwood Road – Windham	58 to 68
Location 11B	Residential	Wildwood Road – Windham	58 to 68
Location 12A	Residential	Route 111A – Windham	58 to 66
Location 12B	Residential	Route 111A – Windham	58 to 66
Location 13A	Residential	West Shore Road – Windham	57 to 61
Location 13B	Residential	West Shore Road – Windham	57 to 61
Location 13 Center A	Residential	Between I-93 travel lanes – Windham	55 to 60
Location 13 Center B	Residential	Between I-93 travel lanes – Windham	55 to 60
Location 14 East	Residential	Gov. Dinsmore Road – Windham	54 to 61
Location 14	Residential	Country Road – Windham	58 to 68
Location 15	Residential	Morrison Road – Windham	58 to 66
Location 16	Residential	Spinnaker Drive – Derry	51 to 66
Location 17	Residential	Tracy Drive – Derry	52 to 66
Location 18	Residential	Fordway Extension – Derry	57 to 69
Location 19	Residential	Mathew Drive – Derry	55 to 66
	Commercial	Kendall Pond Road – Derry	60 to 66
Location 20	Residential	Charleston Avenue - Londonderry	52 to 66
Location 21	Residential	Reo Lane – Londonderry	58 to 66
	Commercial	Londonderry Road - Londonderry	58 to 66
Location 22	Residential	Ash Street - Londonderry	62 to 66
Location 23	Residential	Trolley Car Lane - Londonderry	59 to 66
Location 24	Residential	Seasons Lane - Londonderry	56 to 70
Location 25	Residential	Rockingham Road - Londonderry	49 to 66
Location 26	Residential	Perkins Road - Londonderry	49 to 62
Location 27	Residential	Newton's Meadow Way - Manchester	54 to 67
Location 28	Residential	Bodwell Road - Manchester	50 to 68
Location 29	Residential	Cohas Avenue - Manchester	50 to 67

Source: VHB, Inc.
1 See Sound Level Contours presented in **Figures 3.8-1 to 3.8-23**.

3.9 Visual Resources

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3.9.1 Resource Features

The existing I-93 corridor can be treated as a single visual landscape unit due to the relative uniformity of the topography and adjacent land use. The existing highway is bordered for much of its length within the study area by forest growth, with white pine predominant in upland areas and red maple the most common species in wetlands. This dense forested buffer means that few places afford an extended view from the highway. Similarly, there are a few locations where the highway can be observed from a substantial distance.

In several areas (primarily near the interchanges), development is close to the existing roadway, with a limited, if any, buffer of natural vegetation between the land use activity and the highway. These more urbanized visual units feature commercial and retail developments, which serve motorists and local residents, and are of low visual quality.

Potential areas that may be of scenic concern include land between the highway and Canobie Lake in Salem, Cobbetts Pond and Searles Castle in Windham and Crystal Lake in Manchester.

Scenic resources listed in local community master plans and situated close to the highway corridor include the following:

- A section of Brady Avenue in Salem, west of I-93, unofficially considered a scenic route,
- Some “open vista” areas identified in Derry’s Master Plan, and
- Woodmont Orchards in Londonderry.

It should be noted that the Brady Avenue designation is not formal and that some of the farmland that was the reason for its scenic character was developed in recent years. Derry’s open vista areas have no official designation or protection. Portions of Woodmont Orchards have been sold for development. Table 3-18 contains a listing of all known visual resources in the project corridor.

No scenic easements are known to be associated with the existing highway in the study area.

Table 3.9-1
Visual Resources in the Interstate-93 Project Vicinity

Salem	Brady Avenue scenic road Residential buffers
Windham	Canobie Lake Buffer Cobbetts Pond Buffer Residential buffers Searles Castle
Derry	Open vista to east Open vista to west Residential buffers
Londonderry	Woodmont Orchards Residential buffers
Manchester	Crystal Lake buffer Residential buffers

3.10 Cultural Resources

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3.10.1 Introduction

Preliminary identification of architectural historical, historical, and archaeological resources, collectively known as historic properties under 36 CFR 800, was completed in 1990 through 2003 for the Salem to Manchester I-93 Study Area in the Towns of Salem, Windham, Derry, and Londonderry, and the City of Manchester. The purpose of the investigation is to identify areas of sensitivity that may represent constraints to transportation improvements within the I-93 corridor. The archaeological work was initially conducted in 1990 through 1992 and updated in 2001 through 2003, and the architectural historical survey was completed in 2001 and 2002. The study includes reconnaissance and intensive level architectural history surveys of individual resources and districts, a Phase IA archaeological reconnaissance-level survey of the entire project area, and an intensive level, Phase IB testing of historical and Native American archaeological resources. This report summarizes the results of the archaeological and architectural historical surveys and provides recommendations for further work.

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3.10.2 Regulatory Overview

3.10.2.1 Federal Requirements

Historical properties and archaeological resources that are listed in or are eligible for listing in the National Register of Historic Places are afforded protection by Section 106 of the National Historic Preservation Act (NHPA) and Section 4(f) of the Department of Transportation Act of 1966.

National Historic Preservation Act

Congress enacted the National Historic Preservation Act (NHPA), as amended, in 1966 to ensure that the effects of federal, federally funded, or federally permitted projects on historic buildings, neighborhoods, landscapes, and archaeological sites are considered. Through the NHPA, amended in 1976, 1980, and 1992, Congress sought to involve the federal government as an active participant in the Nation's preservation efforts.

Section 106 of the NHPA requires federal agencies to take into account the effects of their activities and programs on any historic district, site, building, structure, or object that is included, or eligible for inclusion, in the National Register of Historic Places. The resources and the effects on those resources are evaluated by the State Historic Preservation Officer (SHPO) and the federal agencies having jurisdiction, in this case the Federal Highway Administration (FHWA), the lead agency. In New Hampshire, the SHPO is the Director of the New Hampshire Division of Historical Resources (NHDHR). Prior to the approval of the undertaking, the agency must afford the Advisory Council on Historic Preservation (ACHP), established under Title II of the NHPA, a reasonable opportunity to comment on the undertaking.

The procedures followed in the Section 106 review are referred to as the "Section 106 process" and are set forth in regulations issued by the ACHP. The ACHP's regulations, *Protection of Historic Properties* (36 CFR 800), govern the Section 106 process. The ACHP does not have the authority to halt or terminate projects that will affect historic properties. Rather, its regulations emphasize consultation among the responsible federal agencies, the SHPO, and other interested, consulting parties, to identify, evaluate eligibility, determine the potential effect of the project on historic properties, and if possible, to agree upon ways to protect the affected properties.

Public Responsibilities Under Section 106

In addition to the participation of federal and state agencies in the Section 106 review process, the 1999 regulations at 36 CFR 800 require that the federal agencies consult with the public about the projects and its effects on historic properties. The segment of the public specifically involved in the consultation process under these regulations generally

includes immediately affected property owners; local and statewide historical, archaeological, preservation, heritage, and planning organizations; and the Native American community. It is the responsibility of the lead federal agency to provide adequate opportunity for these groups to receive information on the project and share their views. Typically, those individuals and organizations request consulting party status in writing from FHWA, and receive notification of their consulting party status from this agency. Consulting parties are notified of public meetings involving the project and meetings set to specifically discuss historical issues related to the project. Such parties are frequently provided minutes of these meetings. The comments involving historical properties are taken into account during the design stage.

In addition, the information on historical properties developed by state and federal agencies for this project is available to the community, citizens, and local officials, to enact ordinances protecting historic properties. The material can also be incorporated into the community master plan to identify historical resources and preserve them for future enrichment of the community.

Section 4(f) of the Department of Transportation Act

Section 4(f) of the Department of Transportation Act of 1966 (49USC 3030) states that "…special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites." Historic properties are identified under the Section 106 process. Regulations governing 4(f) implementation specify that there can be no taking of public-park or recreation lands, impairment of wildlife and waterfowl refuges, or historic sites without a thorough investigation into all prudent and feasible alternatives. Such alternatives may range from project modifications to "no-build." If it is determined that no prudent and feasible alternative exists and that public park or recreational lands, wildlife and waterfowl refuges, or historic sites must be acquired or impaired, the FHWA must demonstrate that implementation or other alternatives would result in extraordinary costs, and/or social, economic, or environmental impacts. In addition, the proposed project or program must include all possible planning to minimize harm to these historical properties and other resources.

3.10.2.2 State Requirements

The NHDHR is charged under RSA 227-C:9, Directive for Cooperation in the Protection of Historic Resources, with coordination of the identification and evaluation of cultural resources in the State of New Hampshire, which includes the review of historical resources under Section 106.

The NHDHR, in cooperation with the NHDOT and FHWA, has established a method of identification and evaluation to meet the requirements of this historic preservation review. The purposes of this process are to (1) locate and identify historical, architectural, archaeological, and historical archaeological resources within the

project's impact area; (2) apply the criteria for evaluation of significance to a resource to determine possible eligibility to the National Register of Historic Places (National Register), if not already eligible or listed; (3) assess the probable effects of a project on resources listed on or eligible for the National Register; and (4) develop appropriate mitigation methods to lessen the project's impact on affected historic properties.

The NHDHR prepared "Procedures for Identifying Cultural Resources That May Be Affected by State or Federal Transportation Projects in New Hampshire" in November 1992. These procedures were partially updated in 2001. This document offers specific guidance for cultural resource survey efforts undertaken as a component of transportation improvement projects for architectural properties.

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3.10.3 Evaluation of Property Significance: The National Register Criteria, Elements of Integrity, and Historic Contexts

Historical, architectural, archaeological, and historical archaeological properties that are usually fifty or more years in age gain significance for the National Register under four National Register criteria, seven elements of integrity, and the associated historical contexts significant to the local, state, or national historical development. The National Register criteria recognize historic property significance within four areas:

- Criterion A: contribution to the understanding of local, state, and/or national historical trends and events;
- Criterion B: association with historically important individuals;
- Criterion C: representation of architectural styles and building forms and types as well as the work of a master; and
- Criterion D: Native American Pre-Contact or historic data that the property may provide through site investigation.

The seven elements of property integrity, which are not of equal importance in the evaluation of significance for every property, recognize property design, material, workmanship, location, setting, association, and feeling.

The significance of historic properties can be established only when evaluated within their historic context(s). The National Register guidelines explain that "Historic contexts are those patterns, themes, or trends in history by which a specific occurrence, property, or site is understood and its meaning (and ultimately its significance) within prehistory or history is made clear" (National Park Service n.d.: 7). A historic context has three components: the historical theme, the period during which the theme occurred, and the area to which it applies. The theme is the

historical event, historical trend, or cultural complex represented by a property or group of properties. The areas under consideration for this study include the five towns within the project area, the towns of Salem, Windham, Derry, and Londonderry, and the City of Manchester as well as the lower Merrimack River Valley along which the towns are located. The period for a given context is generally defined by the period during which it is represented in the area by its associated properties. Each context is represented by a group of property types. For example, such property types as the gristmill and the commercial flourmill represent the theme of flour milling. Significance evaluation for each property often compares the integrity of the subject property with properties within its property type and associated with its historical context. For example, a brick-making site may be evaluated as ineligible for the National Register because other sites associated with the brick-making context within the region and belonging to that property type and period are more intact and/or may possess more of the elements often displayed by the property type.

The NHDHR recognizes the following themes that characterize pre-contact and historic Native American archaeological properties within the project area: Native American Indian Lithic Technology, Native American Indian Ceramic Technology, Native American Riverine Adaptation/Exploration, Native American Indian Upland Adaptation, and Pre-Columbian Native American Cultures for the Native American archaeological sites.

Significant themes for architectural, historical, and historical archaeological properties within the project area include Orchards and Cider Production, 1650-present; Local Scale Dairying Farming, 1800-present; Dairy Farming for Urban Markets, 1880-1940; Market Gardening and Truck Farming in New Hampshire, 1900-present; Mixed Agriculture and the Family Farm, 1630-present; , 1830-1920; Brick Making for Local and Regional Markets, 1650-1920; Granite Quarrying and Stone Cutting, 1790-Present; The Railroads in NH, 1842-1960; ; Pre-Automobile Land Travel, 1630-1920; Automobile Highways and Culture, 1900-present; Water Supply and Distribution in New Hampshire, 1850-present; European and Middle Eastern Immigration to New Hampshire; Commerce, Industry, and Trade in Village and Town Centers, 1630-Present; Suburban/Bedroom Community Growth in New Hampshire, 1850-present; and Summer Home Tourism, 1880-present

Thus, to evaluate National Register eligibility for historic properties, it must possess significance under one or more of the four criteria, represent a significant historical context, and possess integrity in comparison to other properties of its type.

Brief contexts associated with the archaeological, historical archaeological, architectural/historical properties are noted under the discipline headings below.

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3.10.4 Archaeological Resources

Definitions

Archaeological resources include cultural and culturally associated remains below the surface of the ground as well as ruins above it. The later resources may include standing buildings, structures, and objects when these resources are examined primarily for the data they may contain and relate to associated archaeological deposits.

Native American archaeological resources are those locations and resources once occupied by Native American or Indian peoples. They both pre- and post-date the initial period of European settlement of the Americas, known as the contact period.

For the purposes of this project, historical archaeological resources are those sites and associated resources that usually date to and after the period of initial European contact with Native Americans. They not only include below ground resources and foundations or ruins but also the culturally associated landscapes and standing buildings. The data associated with these sites includes not only the archaeological records but also the written, oral, and pictorial documents. While these resources are examined primarily for the data they may contain, associated standing resources may also gain significance for their architecture.

Method

The locations of known archaeological sites were considered as constraints to the project design in this study. These locations were identified through several Phases of study. The first included a Phase IA, reconnaissance level survey with background research and visual inspection to define areas of archaeological site sensitivity. Such areas are those that are likely to contain archaeological resources, but evidence of archaeological deposits has not necessarily been documented. **Figure 3.10-1 and Tables 3.10-1 and 3.10-2** show the potential archaeological constraints to the project.

Bunker, Potter, and Green (1990) performed the Phase IA, reconnaissance survey of the project corridor including the median and shoulders of the proposed project area in 1989-1990. A documentary review of the state-wide archaeological site files of the Division of Historical Resources and the NH Archaeological Society, the National Register of Historic Places, published and unpublished site reports, local and regional histories, historic maps, and early USGS maps; interviews with local historians; study of local archaeological collections; and review of the environmental characteristics of the survey area using recent topographical maps and soil surveys; and field investigations including a combined walk-over and windshield visual inspection of the project area established expectations for the type and location of archaeological resources for both Native American and historical archaeological sites (Bunker, Potter, and Green 1990: 3-4).

Table 3.10-1
Recommended Phase II Investigations

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001)[1]	2003 Investigations of Site Status (VBI 2003 [IAC 2003]) [2]	Recommendations
Native American Archaeological Resources					
27 Rk 328	Native American	Salem	In 1992, two 30 x 30 meter testing blocks were tested with 23 test units. No Native American materials were found. Three units included four fragments of 20th century materials.	Further testing through the excavation of 20 test units in 2003 located two precontact Native American artifacts, one chert perforator/scraper and one quartz flake.	If supplemental testing indicates more extensive deposits, a Phase II evaluation would follow.
27 Rk 331	Native American	Windham	In 1992, a 30 x 60 meter area was tested with 42 test units using a combination of block, transect, and array testing. Four Native American artifacts were located.	No further work was completed in 2003.	Further evaluation of the site is recommended during supplemental testing and, if needed, Phase II work if the site, which sits at the edge of the project area, is impacted by the project.
27 Rk 333	Native American	Windham	Testing in 1992 identified a small locus of activity with a total of 88 fragments of lithic debitage recovered from two test units. A 22 X 52 m area was tested with 15 test units using a combination of block and array testing.	A walkover was conducted in 2003, noting that the site retains physical integrity.	Currently located on the edge of the proposed right-of-way. If found to be affected during final design, Phase II evaluation recommended. If not impacted, construction fencing separating the site from the construction area may be appropriate.
27 Rk 336	Native American	Windham	Testing in 1992 identified a small locus of activity with a total of seven fragments of lithic debitage recovered from four test units. No evidence of features.	A walkover and mapping were conducted in 2003, noting that the site retains physical integrity.	If supplemental testing indicates more extensive deposits, a Phase II evaluation would follow.
27 Hb 15	Hayward Site	Manchester	Small discrete locus of cultural material including stone tools. Site dates to Late Archaic based on presence of Squibnocket projectile point. Located in 1990-91.	No further examination in 2003.	Phase II evaluation recommended
27 Hb 16	Owens Site	Manchester	Small site, no diagnostic materials. Includes historical archaeological site denoted as the Finn House. Located in 1990-91.	No further examination in 2003.	Phase II evaluation recommended for Native American component.

Table 3.10-1 (continued)

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001)[1]	2003 Investigations of Site Status (VBI 2003 [IAC 2003]) [2]	Recommendations
27 Hb 17	Lovering	Manchester	Possible Late Archaic site with 3 discrete activity areas and possible hearth feature. Located in 1990-91.	No further examination in 2003.	Phase II evaluation recommended
27 Hb 20	Dickey Plain Site Extension	Manchester	Marginal part of site, close proximity to 27 Hb 216 located in 1990-91.	No further examination in 2003.	Phase II evaluation recommended
27 Hb 216	Dickey Plain Site Extension	Manchester	Large site (3500 m2) located on terrace containing Late and Terminal Archaic materials located in 1990-91.	No further examination in 2003.	Phase II evaluation recommended
27 Hb 218	Native American	Manchester	Small locus of activity with two quartz flakes and one quartz biface fragment recovered from one unit.	Phase IB testing in 2003 that supplemented the initial effort with 10 units, located a single flake.	If supplemental testing indicates more extensive deposits, a Phase II evaluation would follow to determine extent of site in right-of-way.
27 Hb 219	Native American	Manchester	High density of cultural material recovered from 13 units during the 1992 study. Materials included quartz, felsite, rhyolite, hornfels flakes, a felsite Neville biface, and one possible feature located. Middle Archaic Period based on Neville Point. Possibly part of the Dickey Plain Site (27-Hb-199). Historic materials included iron, glass, yellow ware, whiteware, and stoneware. A 22 X 90 m area was tested with 35 units in block and transects.	In the 2003 testing, 11 of the 15 units excavated in Phase IB recovered fire cracked rock, 38 quartz, rhyolite, and felsite flakes; 1 Small-Stem point; 1 Neville point variant; a bone fragment; and a feature containing a dark stain and fire-cracked rock. The diagnostic projectile points indicate a Late Archaic occupation. The site appears to represent a small habitation site.	Phase II evaluation recommended.
27 Hb 220	Native American	Manchester	In 1992, cultural material recovered from eight test units including felsite, quartz, rhyolite, hornfels, and jasper flakes and 1 biface fragment. Limited historical material located. A 60 X 90 m area was tested with 52 units using a block method.	The ten shovel tests in Phase IB testing in 2003 did not produce further pre-contact Native American artifacts. The site appears to represent a small habitation site.	Phase II evaluation recommended.

Table 3.10-1 (continued)

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001)[1]	2003 Investigations of Site Status (VBI 2003 [IAC 2003]) [2]	Recommendations
Historic Archaeological Resources					
27 Rk 364	Boyer Lane Granite Quarry	Salem	Quarry site noted in 1990-91.	Investigation mapped and photographed the feature in 2003. It located the 19th c. granite quarry including three flooded pits, many pieces of granite blocks cut with a plug drill (post-1830), and waste material.	Further investigations would include research to identify operator and period of operation. No further excavation is currently recommended, but may change depending on the results of the research.
27 Rk 7	John Dinsmore Site	Windham	Stone dwelling foundation with brick chimney dating to 1811, rectangular depression of outbuilding, and cistern. Remains noted but not tested during the 1990-91 studies.	Revisited in 2003: Walkover, mapping, and photography completed. Features noted in 2003 include stone-lined cellar hole with large stone chimney, cistern, and outbuilding depression. No shovel testing has occurred.	Phase II evaluation recommended.
27 Rk 365	Indian Rock Road Dam	Windham	Small stone dam at outlet to silted pond noted in 1992 study.	Walkover, mapping, and photography and limited research completed	Phase II testing recommended including more extensive research on the site
27 Rk 366	Searles Estate	Windham	Searle Estate random rubble stone and mortar wall at Searle School and in the Median of I-93 along NH Route 111A. Walls reach about 7'- 8' high.	The walls were mapped and photographed. The wall remnant in the median has undergone some disturbance and is separated from the rest of the property. It will be destroyed by the project.	The two wall sections should undergo further documentation and identification by an architectural historian. Its location on original I-93 plans should be traced. As much of the walls as possible should be retained.
27 Rk 367	W.A. Dinsmore House	Windham	Not identified in 1990-92 studies.	The 2003 study conducted mapping, photography, and excavation of four units. It reported a mortared stone foundation and cellar hole filled with burned timbers, other architectural debris, and a collapsed hearth. 4 test units revealed primarily architectural artifacts. The site pre-dates 1857.	Phase II site evaluation recommended.
27 Rk 368	W. Parker House	Windham	Not identified in 1990-92 studies.	Walkover, mapping, photography, and excavation of 6 shovel tests and limited research completed. Cut granite stone foundation (barn?) present by 1858 and associated 147 artifacts identified.	Phase II testing recommended including more extensive research on the site

Table 3.10-1 (continued)

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001)[1]	2003 Investigations of Site Status (VBI 2003 [IAC 2003])[2]	Recommendations
27 Rk 369	O. Parker House	Windham	Not identified in 1990-92 studies.	Walkover, mapping, photography, and 9 shovel tests and limited research completed. Rubble foundation, cellar hole, and stone-lined well present by 1892. Associated artifacts recovered.	Phase II testing recommended including more extensive research on the site
4-38/40/47-28	Old County Road (Honeywell Road)	Windham	Old County Road roadbed reported in 1990 study. It extends between Indian Rock Rd. and current County Rd. near Bridge St. Pond.	Walkover, research, photography, and mapping completed in 2003. The feature includes a 15' wide gravel road flanked by stonewalls and ditching. About four dwelling foundations remain extant along the road. Extant by 1858.	Further research and field investigations at adjacent foundations may justify establishing an archaeological district that would include a part of the Old County Road connector.
27 Rk 370	L.H. Corthell Farmstead	Londonderry	Not identified in 1990-92 studies.	The 2003 study included walkover, mapping, photography, and the excavation of 17 test units recovering 2,560 artifacts. It recorded house and barn foundations of dried-laid stone and a well nearby.	A phase II evaluation is recommended.
27 Rk 371	G.W./O.W. Crispin Homestead	Londonderry	Cellar hole noted in 1990 survey.	The 2003 study conducted a walkover, mapping, photography, and the excavation of 9 test units. It included a dry-laid, potentially early outbuilding foundation and cellar hole and a depression. 4 of 9 units recovered seven artifacts.	Phase II evaluation recommended.
27 Rk 372	Stonehenge Road Farmstead	Londonderry	Not identified in the 1990-92 studies.	Walkover, mapping, photography, and the excavation of 14 test units and limited research completed. Late 19th/early 20th century farm-stead with 2 remaining outbuilding foundations, one of which may have been a blacksmith shop.	Phase II testing dependent on the results of more detailed research on the site, specifically the potential blacksmith shop
27 Hb 18	Dickey Road Brickyard Site	Manchester	Small, family operated brickyard dating to the mid-1800's located and tested in 1990-91.	No further examination in 2003.	Phase II evaluation recommended
27 Hb 19	Corning Mill Site	Manchester	Mill site on Cohas Brook including exposed walls and the walls of two foundations. May date to 1787. Located in 1990-91.	Re-examined in 2003 through walkover, mapping, photography, and five shovel tests.	Phase II testing and additional research are recommended because of the scarcity of such resources from the 18th century.

1 Bunker, Potter, and Green (1990) and Public Archaeology Laboratory (1992/1998-2001).
2 Bunker and Wheeler (2003).

Table 3.10-2
Archaeological Sites Found Ineligible for the National Register or No Longer Impacted by the Project after Completion of 2003 Investigations

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001) [1]	2003 Phase IB Investigation of Site Status (VBI 2003 [IAC]) [2]	Recommendations
27 Rk 327	Historic Dump	Salem	Testing in 1992 located twentieth century deposits containing plastic, glass, and slag.	Site was not visited during the 2003 investigations because of limited content and 20th century date.	No further investigations recommended.
27 Rk 328	Historic Dump	Salem	Small fragments of ceramic with red bodied coarse and earthenware, a machine-cut nail, and calcined bone located in 1992 testing.	Site was examined in 2003 for Native American remains. The limited historic component is a field scatter.	No further investigation of historic component recommended. Native American component will receive further evaluation.
27 Rk 329	Historic Dump	Salem	Twentieth century deposit including aluminum and molded glass located during the 1992 testing.	Site was not visited during the 2003 investigations because of limited content and 20th century date.	No further investigations recommended.
27 Rk 330	Historic Dump	Salem	Iron and glass located during the 1992 testing.	The location has been developed as a residential lot.	No further investigations recommended because of site disturbance.
1-7-3	Area of Native American Sensitivity	Salem	A 15 x 30 meter area was tested as a block with 7 test units. No archaeological remains located.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.
2-10-7	Area of Native American Sensitivity	Salem	A 45 x 45 meter area was tested with 4 test units that were judgmentally placed. No archaeological remains located.	20 test units supplemented the original testing. Significant archaeological deposits were not identified.	No further investigation recommended.
2-10-8	Area of Native American Sensitivity	Salem	A 15 x 30 meter area was tested with 6 test units along transects. No archaeological remains located.	20 test units supplemented the original testing. Significant archaeological deposits were not identified.	No further investigations recommended.
2-13/15-5	Mass. and So. NH Electric RR	Salem	Trolley bed remains noted in 1990-91.	Investigations completed a walkover, mapping, photography, and limited documentation completed.	Construction impacts only the section in median, which has already undergone disturbance. No further work recommended.
2-13-6	Abutments	Salem	Stone Bridge Abutments noted in 1990-91.	Unable to relocate remains. Appear to be no longer extant.	No further investigations recommended.
2-15-13	Area of Native American Sensitivity	Salem	A 22 x 30 meter area was tested as a block with 11 test units. No archaeological remains located.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended

Table 3.10-2 (continued)

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001) [1]	2003 Phase IB Investigation of Site Status (VBI 2003 [IAC]) [2]	Recommendations
2-17-11	Taylor Grist Mill Site	Salem	Taylor Grist Mill Site remains noted in 1990-91.	Walkover and research identified and described the visible remains of two 19th century gristmills.	Resources are outside the right-of-way and no further investigations are recommended.
3-24-20	Area of Native American Sensitivity	Salem	An area containing a single historic artifact was tested with 10 units along one transect.	20 test units were excavated to supplement the original testing. Significant archaeological deposits were not identified.	No further investigations recommended.
27 Rk 8	County Rd. Dugout Site I	Windham	Cellar hole with partially collapsed wall.	Early borrow pit for County Road (Honeywell Road)	No further investigations recommended; not a significant resource.
27 Rk 9	County Rd. Dugout Site II	Windham	Similar to 27 Rk 8.	Early borrow pit for County Road (Honeywell Road)	No further investigations recommended; not a significant resource.
27 Rk 316	Barlow Site	Windham	Found in 1990-91 through an interview with the landowner, the site contained small quartz points and a steatite pipe.	Walkover located site well outside the project area.	No further investigations recommended because site occurs outside project area.
27 Rk 332	Historic Well	Windham	Isolated stone-lined well with no historic cultural material recovered during subsurface testing in 1992. A limited review of historic maps did not provide identification of the property.	Site was not visited during the 2003 investigations because of limited content.	No further investigations recommended.
27 Rk 334	Stone Bldg. Foundation	Windham	North wall and portions of east and west walls visible in 1992. No historic material recovered during subsurface testing. Initial review of historic maps did not provide identification of the property.	A walkover examining the area of the site found that it was no longer extant.	No further investigations recommended.
27 Rk 335	Stone Dam	Windham	Stone dam associated with small pond. No historic material recovered during testing in 1992. Initial review of historic maps did not identify property.	Inspection of the dam found it to be a recent check dam and outside the current right-of-way.	No further investigations recommended.
27 Rk 337	Historic Dump Site	Windham	Site contained glass, iron, brick, whiteware, creamware, earthenware, red-bodied ware, pearlware, and porcelain. No evidence of building remains with initial testing in 1992.	Walkover of area found that the site location is outside the right-of-way. It appears to be field scatter.	No further investigations recommended.

Table 3.10-2 (continued)

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001) [1]	2003 Phase IB Investigation of Site Status (VBI 2003 [IAC]) [2]	Recommendations
27 Rk 343	Indian Rock	Windham	A large stone with commemorative plaque. Reputedly used to ground corn. Eligible as a commemorative marker under Criterion A/Exception F.[3]	A walkover of the area along NH Route 11 in 2003 including the area of the stone marker was conducted, and it did not demonstrate archaeological sensitivity. [3]	No further investigations recommended.
J. Parker House	Domestic site	Windham	Metal debris remaining from a farmstead destroyed during the construction of I-93 in the 1960s	Walkover, mapping, photography, and limited research	Most of the site is now occupied by I-93. No further investigations recommended.
3-28/29-13	Old Barlow Road	Windham	Old Road Bed (I-93 crossover) noted in 1990-91 study.	Walkover and photography documented its remains and adjacent stonewalls. It now serves as a crossover for I-93.	The site is not a significant historical resource. No further investigations recommended.
3-30-24	Area of Native American Sensitivity	Windham	A 37 x 45 meter area was examined without subsurface archaeological testing. The area contained a disturbed, rubble stone foundation. No artifacts deposits were identified.	20 test units were excavated to supplement the original testing. Significant archaeological deposits were not identified. The area is now disturbed and contains modern trash.	No further investigations recommended.
3-31-17	Foundations	Windham	Barn Foundation that may be located on the Dinsmore property (site 27-Rk-7) identified by 1990-91 study.	Walkover verified that the resource is outside the project area.	No further investigations recommended.
3-32-21	Roadbed	Windham	Old Rte. 111A Road Bed noted in 1990-91 study.	A site visit verified that Route 111A maintains its original roadbed and now functions as a modern road with a number of historic buildings along it.	The site is not a significant historical resource. No further investigations recommended.
3-33-25	Building remains	Windham	Collapsed structure and barn foundation noted in 1990-91 study.	A site visit indicates that the area of the site has undergone recent development and that it is located outside the project area.	No further investigations recommended.
4-38-29	Old County Road	Windham	Stone Bridge Abutments identified in 1990-91.	Bridge abutments were not relocated during the walkover of this area. However, the remains of a recent check dam were located near the site.	No further investigations recommended.
4-42-30	Dinsmore Property	Windham	Carriage house foundation associated with a Dinsmore property and now on Brentwood Estate. Identified in 1990-91.	Walkover of the area failed to locate the subject foundations inside the project area.	No further investigations recommended.

Table 3.10-2 (continued)

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001) [1]	2003 Phase IB Investigation of Site Status (VBI 2003 [IAC]) [2]	Recommendations
4-43-31	Stone dump	Windham	Stone dump identified in 1990-91	Walkover found a borrow pit in this location.	No further investigations recommended.
4-45-30B	Area of Native American Sensitivity	Windham	A 37 x 37 meter area was tested with 5 test units in a block. No Native American artifacts were identified.	Walkover and 50 test units were excavated to supplement the original testing. Significant archaeological deposits were not identified.	No further investigations recommended.
4-47-33	Area of Native American Sensitivity	Windham	A 15 x 15 meter area was examined by placing 4 test units along transects. A historic stone dam was present. No artifact deposits were located.	20 test units were excavated to supplement the original testing. Significant archaeological deposits were not identified. Not considered significant, the dam is a recent, post 1953 structure and now outside the right-of-way.	No further investigations for the Native American or historic component recommended.
4-48/50-33	Road	Windham	Old roadway identified in 1990-91 study.	Walkover located a relatively recent road or trail.	No further investigations recommended.
4-52/54-35	Manchester and Lawrence Railroad	Derry	Abandoned Rail Bed along the B & M line. Extant by the mid-1800s Identified by the 1990-91 survey.	The resource was mapped and photographed and identified through historical research.	No further investigation recommended.
4-54-40	Area of Native American Sensitivity	Derry	An area was tested with 11 test units using the block method. No archaeological deposits were located.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.
4-55/56-36	Road	Derry	Old roadway identified in 1990-91 study.	Walkover failed to locate an old road corridor in the identified location.	No further investigations recommended.
4-57-41	Area of Native American Sensitivity	Derry	A 22 x 30 meter area was tested with 13 test units using the block method. No archaeological deposits were located	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.
4-59-45	Area of Native American Sensitivity	Derry	A 37 x 90 meter area was tested with 8 test units along transects. No archaeological deposits were located.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.
4-62-46	Area of Native American Sensitivity	Derry	An area was tested with 13 test units using the block method. No archaeological deposits were located.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.

Table 3.10-2 (continued)

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001) [1]	2003 Phase IB Investigation of Site Status (VBI 2003 [IAC]) [2]	Recommendations
5-67-39	Trolley Line	Londonderry	Trolley track bed, currently paved and known as Trolley Car Lane, identified in 1990-91 study.	Walkover located the former line and located a small portion of the truncated feature in the project area. Given its relatively recent conversion to a roadway, the resource no longer appears significant.	No further investigations recommended.
5-67-47	Area of Native American Sensitivity	Londonderry	A 15 x 22 meter area was tested with 4 test units along transects. No archaeological deposits were located.	Walkover verified that the area had undergone disturbance since 1992 and was now outside the project area.	No further investigations recommended.
5-67/69-40	Old Pillsbury Road	Londonderry	Old Pillsbury Road bed identified in the 1990-91 study.	Walkover identified the feature as an old telephone corridor. Pillsbury Rd. is located outside the project area.	No further investigations recommended.
5-69-44	Collapsed structure	Londonderry	Collapsed structure located by the 1990-91 study.	Walkover in the area failed to identify the building remains. It may now lie outside the project area.	No further investigations recommended.
5-70/74-45	Road	Londonderry	Old roadbed identified in 1990-91 study.	Walkover identified the feature as an old telephone corridor.	No further investigations recommended.
5-71-49	Area of Native American Sensitivity	Londonderry	A 15 x 15 meter area was tested with 14 test units along transects. No archaeological deposits were located.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.
5-71-50	Area of Native American Sensitivity	Londonderry	A 15 x 22 meter area was tested with 4 test units along transects. No archaeological deposits were located.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.
5-77/79-47	Manchester and Lawrence Railroad	Londonderry	Abandoned Rail Bed along the B & M line. Extant by the mid-1800s Identified by the 1990-91 survey.	The resource was mapped and photographed and identified through historical research.	No further investigation recommended.
6-79-48	Stonewall	Londonderry	Stonewall enclosure located in the 1990-91 study.	Walkover identified the resource as the intersection of two stonewall fragments.	No further investigations recommended.
6-79-56	Area of Native American Sensitivity	Londonderry	A 15 x 105 meter area was tested with 10 test units along transects. No archaeological deposits were located	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.

Table 3.10-2 (continued)

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001) [1]	2003 Phase IB Investigation of Site Status (VBI 2003 [IAC]) [2]	Recommendations
6-79-57	Area of Native American Sensitivity	Londonderry	A 15 x 37 meter area was tested with 6 test units along transects. No archaeological deposits were located.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.
6-82-49	Clark Road	Londonderry	Old roadbed identified in 1990-91 study.	Walkover located a portion of an existing road known as Clark Road that is truncated by I-93.	No further investigations recommended.
27 Hb 26	Historic Dump Site	Manchester	Site contained porcelain, glass, iron, buff-bodied coarse ware, whiteware, and brick	10 units excavated at the site. The historic component was found to be disturbed.	No further investigations of the historic component recommended.
27 Hb 221	Historic Dump Site	Manchester	Site contained molded and unmolded glass, whiteware, yellowware, stoneware and iron. No evidence of structural building remains with initial testing.	Walkover and the excavation of systematic test units found that the site has received significant disturbance and represents an artifact scatter.	No further investigations recommended.
27 Hb 222	Historic Dump Site	Manchester	One fragment of iron located during 1992 testing. Initial review of historic maps failed to identify the property owner.	Site was not visited during the 2003 investigations because of limited content.	No further investigations recommended.
6-92-82	Area of Native American Sensitivity	Manchester	A 45 x 45 meter area was tested with 4 judgmental test units. No archaeological deposits were located.	20 test units were excavated to supplement the original testing. Significant Native American archaeological deposits were not identified, and the 19th and 20th century artifacts represent a general artifact scatter.	No further investigation recommended for the historic and Native American components.
6-92-83	Area of Native American Sensitivity	Manchester	A 22 x 30 meter area was tested with 20 test units using a combination of block and transect methods. One historic artifact was located.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.
6-93/94-51	Brickett Road	Manchester	Remains of Brickett Road Bed identified in the 1990-91 study.	Walkover failed to identify any sections of the road in the project area.	No further investigations recommended.
6-94-89	Area of Native American Sensitivity	Manchester	A 45 x 105 meter area was tested with 19 test units using a combination of the block and transect method. No archaeological deposits are identified.	SHPO determined that testing was adequate given the geographic setting and nature of the original testing.	No further investigations recommended.

Table 3.10-2 (continued)

Site No.	Name/ Site Type	Town	1990-1992 Investigations (VBI 1990-91; PAL 1992/1998-2001) [1]	2003 Phase IB Investigation of Site Status (VBI 2003 [IAC]) [2]	Recommendations
6-96-91	Area of Native American Sensitivity	Manchester	The 15 x 75 meter sensitive area was not tested.	SHPO determined that testing was not necessary given the geographic setting and nature of the original testing.	No further investigations recommended.

1 Bunker, Potter, and Green (1990) and Public Archaeology Laboratory (1992/1998-2001)
2 Bunker and Wheeler (2003)
3 Determined through an architectural survey conducted by Lynne Emerson Monroe for VHB and a walkover of the area contracted directly to Victoria Bunker, Inc. by NHDOT.

From this reconnaissance investigation, archaeological sensitivity areas were selected and mapped for more intensive documentary and field investigations in later phases of study. Native American sites were expected along major and minor water courses including Cohas, Policy, Beaver, Porcupine, and Harris brooks, along the margins of lakes or ponds including Canobie Lake and Cobbetts Pond, along the margins of wetlands, and in several types of upland settings. Preferred Native American site locations were expected to coincide with level, well-drained, terraces near surface water features particularly at the confluence of streams. Locations with stony or poorly drained soil associations and steep slopes and irregular terrain were not likely to be archaeologically sensitive for Native American sites. Locations of Native American archaeological sensitivity included the banks of the Porcupine, Golden, and Beaver brooks and a large interior wetland of the Canobie Lake drainage. In addition to those selected on the basis of their natural setting, sensitive areas also included locations with previously recorded sites. For the upland areas on minor streams and wetlands, small, special activity or seasonal Native American sites of any period were anticipated on the basis of earlier archaeological studies. In addition, sites along the Cohas drainage were expected to exhibit evidence of multiple habitations and to include a diversity of tools and materials in their artifact assemblages. Sites might range in size between 5 square meters and 100 square meters. Although they may occur in any period, those with a Late Archaic temporal affiliation dating between ca. 6000 and 3000 before the present (B.P.) appear most likely.

Expectations for the type and setting of historical archaeological resources were also developed during this 1990 reconnaissance survey. Documents analyzed for this portion of the study included local and regional histories, historic maps, and the NHDHR site files and inventory of historic properties. On the basis of this research, the following site types were anticipated: abandoned travel routes such as rail beds and road corridors, remains of dwellings and farmsteads, isolated dumps, mill remains, and the remains of other local industries and craft locations (Potter and Bunker 1991: 5-8).

Potter and Bunker completed the intensive, Phase IB archaeological study of twenty archaeologically sensitive locations within the median of the project corridor in 1991 (Potter and Bunker 1991). The intensive survey of these sensitivity areas included additional pedestrian inspection and continued map research to understand the local topography and soils as well as the level of disturbance from previous highway construction. This review eliminated one location and reduced testing in others. A sampling strategy was devised for each sampling area. Multiple transects placed at 8 meter intervals were generally placed along the margins of natural features, following natural brook courses, wetland boundaries, and terrace edges. Tests were placed at 8-meter intervals along each transect. Measuring 50 X 50 cm, all shovel tests were excavated by hand to culturally sterile subsoil. Soils were screened through one-quarter inch wire screening. Notations about soil color, soil texture, artifact content, disturbances, anomalies, and natural features were made on standard forms. Scaled field sketches depicted the location of the testing and natural

and cultural features. Artifacts were processed and deposited at the NHDHR. The locations of historical archaeological sites were examined through pedestrian survey. Intensive, Phase IB subsurface testing at historical archaeological sites occurred only at the Dickey Road Brickyard site (27 Hb 18) along Cohas Brook. At the other sites, data were gathered from documentary sources and surface inspection to determine the age, size, function, and character of the resources. Site inventory forms were completed and Smithsonian site numbers were assigned for each identified Native American and historical archaeological site.

In 1992, the Public Archaeology Laboratory (PAL) conducted supplemental testing at 42 Native American archaeologically sensitive areas that were identified by Bunker, Potter, and Green in 1990 areas along the shoulders of the I-93 corridor. PAL conducted a walk-over of each of the sensitivity areas along the shoulders to determine the testing method. They utilized one of three testing methods. Ten sensitivity areas were eliminated from further investigation at this stage because of disturbance. In addition, a field scatter of historic cultural materials was gathered in eight of these areas, and three aboveground, historic features were identified.

The survey methods for the remaining 32 sensitivity areas included: 1. survey at 10-meter intervals along one or more transects in small testing areas; 2. excavation of an array of 13 shovel tests in a staggered grid pattern in 30-meter by 30-meter blocks, or 3. judgmental placement of units. All units measured 50 cm by 50 cm and were excavated to sterile soil. Screening occurred through a one-quarter inch wire mesh. Investigated areas were mapped and recorded. However, historical archaeological sites did not receive subsurface investigation. The final report for this study was completed in 2001 (PAL 2001: 6-16).

Because the historical archaeological sites and aboveground remains were treated somewhat differently during the archaeological surveys, a summary of project approach specific to these sites is noted. The potential for the project area to contain historical archaeological sites was examined in several phases of the study. The reconnaissance, Phase IA study in 1990 by Bunker, Potter, and Green, identified locations sensitive for these sites both in the median and along the shoulders of the project area. Their study included pedestrian surface inspection for depressions, aboveground artifact deposits, and building remains as well as the examination of historic maps and secondary sources that might suggest past site locations. The 1990 reconnaissance study generated a list of 57 historical structures, ruins, and depressions along the shoulders and in the median that required Phase IB investigations. Although the reconnaissance study of 1990-1991 by Potter and Bunker identified many other historical archaeological sites in the median, they conducted Phase IB or intensive testing at only one historical archaeological site, the Dickey Road Brickyard Site. The supplemental testing conducted by the PAL in 1992 along the shoulders tested to a supplemental Phase IA level only the historical archaeological sites located within the archaeologically sensitive areas associated with Native American remains identified by Bunker, Potter, and Green's 1990 reconnaissance survey. Quarry sites, dams, grist and sawmill sites, collapsed buildings, building foundations, cellar holes, and associated

features at farmsteads and dwelling sites, stonewall enclosures, old roads, and dumps were potentially historical archaeological sites.

Following a public hearing and the identification of the Selected Alternative, Phase IB investigations in the spring of 2003 further examined the extent of project impacts on archaeological resources along this corridor (Bunker and Wheeler 2003). During a review of all identified sites and sensitivity areas with NHDHR, 17 locations identified for further Phase IB testing that had undergone limited testing in the supplemental investigations of 1992 were eliminated on the basis of environmental characteristics, evidence of disturbance, and limited artifact and feature content. The remaining areas listed in Tables 3.10-1 and 3.10-2 underwent sufficient testing to bring the excavation unit interval to 8 meters and examine adjacent areas. The 2003 study also included a pedestrian survey of the entire corridor to locate potential sites not located in the 1989-1992 efforts and to examine the condition of sites that had undergone intensive Phase IB testing. This effort resulted in the elimination of 56 sites and archaeologically sensitive areas (Table 3.10-2) and the identification of 25 sites, 12 Native American and 13 historic sites, for Phase II testing following project approvals (Table 3.10-1). Note that although one of these 25 locations, massive stone walls associated with the Searles Estate, was identified during the 2003 pedestrian survey effort, this feature will require further documentation by an architectural historian.

The project includes the design of park-and-ride lots at Exits 2, 3, and 5. The locations of the park-and-ride lot facilities were not determined until late in the preliminary design phase and were consequently not reviewed as part of the initial reconnaissance level survey by Bunker, Potter and Green (1990). As park-and ride-sites, and their options, were identified Phase IA investigations were conducted by PAL, Bunker, or Independent Archaeological Consulting to determine the level of archaeological sensitivity at each location. Park-and-rides received only surface inspection and a document review, including the statewide site survey files at the NHDHR and the inspection of a limited number of historic maps. They did not undergo subsurface testing.

Because of the level of disturbance and steep slopes within the proposed areas, all but two areas were determined to have low archaeological sensitivity. A portion of the proposed site at Exit 5 possesses a moderate archaeological sensitivity, due to its location adjacent to wetlands and an intermediate stream. In addition, the Boyer Quarry Site, identified by Bunker and Wheeler (2003), is also located within the Exit 2 park-and-ride site. As a result, further archaeological studies will need to occur at these two locations (Table 3.10-3).

Many of the wetland mitigation sites were selected late in the EIS process. The majority of these sites will be preserved, which will not result in the disturbance of the ground surface or any potential associated archaeological sites. At locations where archaeological remains are visible above ground surface, for example, ruins such as foundations, and there are no plans for alterations to the site, the NHDOT will complete a minimal NHDHR Archaeological Inventory Form to track their presence.

This includes mapping, photographing, describing the location, determining site boundaries, and conducting sufficient research to identify these features. If ground-disturbing activities were to occur at any of these locations, by the creation of wetlands or other activities, the archaeologically sensitive portions of the preservation area will need to undergo phased investigations as summarized in Table 3.10-3.

Table 3.10-3
Archaeological Survey at Park-and-Rides and Wetland Mitigation Sites

Location/Name	Town	Description of Parcels	Level of Survey Completed/Recommended
Park-and-Rides			
Exit 2: Fairmont Rd	Salem	The Phase IA investigations by PAL, and Bunker and Wheeler indicate that the area proposed for the 430-space park-and-ride has been heavily disturbed by industrial and residential development. Phase IB did identify the Boyer Lane Quarry Site at that location.	Further research and necessary follow-up fieldwork will be completed at the Boyer Lane Quarry Site (27 Rk 364) during Phase II.
Exit 3: NH 111A (Range Rd).	Windham	Phase IA investigations by PAL, and Bunker and Wheeler did not locate an archaeologically sensitive area within the proposed 510-space park-and-ride, to be constructed within the existing I-93 median. The area is undeveloped and steep with much exposed ledge.	Because of the absence of sensitivity areas, no further survey recommended.
Exit 5: NH 28 (Rockingham Rd.)	Londonderry	PAL evaluated the proposed site of the 480-space park-and-ride for sensitivity. Although much of it includes landfill sites and wetlands, some undisturbed areas exist.	Phase IB survey will occur at undisturbed locations.
Wetland Mitigation Sites			
#30: Cluff Crossing Rd.	Salem	The 27-acre site includes the confluence of Policy and Porcupine brooks. Although much of the area is disturbed by a man-made pond and a recreation field, some locations of undisturbed areas exist. Preservation is proposed for this site.	Survey in the disturbed areas is unnecessary. If future projects are identified in this area such as the transfer of the property to the town, all necessary phased archaeological survey beginning at the combined Phase IA - Phase IB level will be completed along the uplands adjacent to the wetlands, the undisturbed locations at this site.
#31: Pelham Road	Salem	The 24-acre site, which abuts Porcupine Brook, includes an advance wetland creation site of 4 acres. The remainder is mostly existing wetlands. Undisturbed upland areas along the wetlands are archaeologically sensitive. Preservation will occur at this site.	The Phase IA sensitivity assessment was completed prior to the completed wetland creation project. Because the site is being preserved, there will be no land disturbance and no further survey will be completed at this time. If future projects are identified in this area, all necessary phased archaeological survey beginning at the combined Phase IA - Phase IB level will be completed along the uplands adjacent to the wetlands, the undisturbed locations at this site.
#32: Salem Wastewater Treatment Plant	Salem	The upland area of the 32-acre site has been heavily disturbed by the construction of the wastewater treatment plant. The floodplain area contains undisturbed locations. The upland area may include approximately 10 acres of wetland/floodplain creation, and the remainder including the floodplain area will be preservation.	Because of the high level of disturbance along the upland, no further survey is recommended. Because the areas in the floodplain are being preserved, there will be no land disturbance and no further survey will be completed at this time. If future projects are identified in this area, all necessary phased archaeological survey beginning at the combined Phase IA - Phase IB level will be completed along the floodplain, the undisturbed location at this site.

Table 3.10-3 (continued)

Location / Name	Town	Description of Parcels	Level of Survey Completed/Recommended
#38: Baggett Property	Salem	The 6-acre site, which includes forested areas adjacent to prime wetlands, will involve both wetland creation and preservation. This property is archaeologically sensitive.	Areas selected for wetland creation will undergo the appropriate phases of archaeological survey. Those areas selected for preservation, which are not covered by wetlands, will undergo surface inspection to locate the visible archaeological features and record them on a minimal archaeological inventory form. Because wetlands are being preserved, there will be no land disturbance and no further survey will be completed at this time. If future projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.
#24: Highway Median	Windham	The 17-acre site lies between the existing barrels of I-93 at Exit 3. Approximately three acres of wetland creation, along the existing northbound barrel, and 14 acres of preservation will occur in these former farm fields. Some portions of this area were disturbed by the previous construction along I-93. The area has been examined at the Phase IA level.	Archaeologically sensitive areas within the wetland creation area will undergo a Phase IB investigation. Because the remainder of the site is being preserved, there will be no land disturbance and no further survey will be completed in these areas at this time. If future projects are identified in these areas, all necessary phased archaeological survey will be completed in undisturbed locations.
#45: Southeast Lands	Windham	The 290-acre combined parcels include undisturbed, continuous forested upland and wetland areas. Preservation will occur in this potentially archaeologically sensitive area.	Locations that are not covered by wetlands will undergo surface inspection to locate the visible archaeological features and record them on a minimal archaeological inventory form. Because the sites are being preserved, there will be no land disturbance and no further survey will be completed at this time. If future projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.
#49: Armstrong Property	Windham	The 11-acre site includes undeveloped areas under oak cover. Some areas contain exposed ledges. Preservation will occur in this potentially archaeologically sensitive area.	Locations that are not covered by wetlands and ledge will undergo surface inspection to locate the visible archaeological features and record them on a minimal archaeological inventory form. Because the site is being preserved, there will be no land disturbance and no further survey will be completed at this time. If future projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.
#16: Sybiak Farm Property	Derry	The 198-acre site includes upland forest, abandoned farm fields, orchards, and wetlands. The dwelling and barn burned in 2002. Preservation will occur in this area, which contains potentially archaeologically sensitive areas.	This area has been examined for surface features, which now include stonewalls and one small, collapsed outbuilding. These features will not be disturbed. Because the site is being preserved, there will be no land disturbance and no further survey will be completed at this time. If future projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.
#14 & 15: South Road Site	Londonderry	The area contains 75 acres. The excavation of sand pits has disturbed large portions of this area. Wetland creation affecting 12 acres will occur in this disturbed area. There are undisturbed areas that would attract Native American settlement such as lands along Beaver Brook and along the tops of glacial moraines. The 63-acre preservation area includes one archaeological site.	This area has been examined for surface features. The surface features of the South Road Site were recorded and entered into the Archaeological Inventory as 27 Rk 348. This site will be fenced and will not be disturbed during wetland creation, and will be preserved in perpetuity. The wetland creation site occurs within disturbed lands. Because the undisturbed lands will be preserved, there will be no land disturbance and no further survey will be completed at this time in these areas. If future projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.

Table 3.10-3 (continued)

Location / Name	Town	Description of Parcels	Level of Survey Completed/Recommended
#58: Scobie Pond	Londonderry	This 67-acre parcel is entirely forested with oak, pine, and mixed deciduous forest stands on ledgey hillsides. Swamplands cover some of the area. Preservation will occur in this area, which may contain potentially archaeologically sensitive areas near water sources.	Undisturbed locations that are not covered by swampland and ledge will undergo surface inspection to locate the visible archaeological features and record them on a minimal archaeological inventory form. Because the site is being preserved, there will be no land disturbance and no further survey will be completed in these areas at this time. If future, land-disturbing projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.
#61: Musquash Expansion	Londonderry	This 108-acre tract is composed of forested upland some of which underwent recent logging. Less disturbed areas may be archaeologically sensitive. Preservation will occur in this area.	Locations that are not disturbed by modern logging and that are not covered by wetlands will undergo surface inspection to locate the visible archaeological features and record them on a minimal archaeological inventory form. Because the sites are being preserved, there will be no land disturbance and no further survey will be completed in these areas at this time. If future, land-disturbing projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.
#63: Norwood Group Parcel	Londonderry	About 80% of the 37-acre parcel contains diverse wetlands that lie adjacent to the perennial tributary to Beaver Brook. Lands bordering the wetlands, which are undisturbed, may contain archaeologically sensitive areas. Preservation will occur in this area.	Undisturbed locations that are not covered by wetlands will undergo surface inspection to locate the visible archaeological features and record them on a minimal archaeological inventory form. Because the site is being preserved, there will be no land disturbance and no further survey will be completed in these areas at this time. If future, land-disturbing projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.
#3: Filip Farm Site	Manchester	This 16-acre site contains open farm fields and wetlands along Mosquito Brook. The area appears to be archaeologically sensitive and will undergo preservation.	The 16 acres have been examined and no visible archaeological features were found. Because the site is being preserved, there will be no land disturbance and no further survey will be completed in these areas at this time. If future, land-disturbing projects are proposed in this area, all necessary phased archaeological survey will be completed in undisturbed locations.
#47: Greek Picnic Grounds	Manchester	This 40-acre parcel is located along a wooded upland and includes some level areas. It once included a pavilion. Level areas on the parcel may be archaeologically sensitive. The area will be preserved to protect the watershed to Crystal Lake.	The level areas on the parcel appear to be archaeologically sensitive and will undergo surface inspection to locate the visible archaeological features and record them on a minimal archaeological inventory form. The site of the pavilion will also be noted. Because the site is being preserved, there will be no land disturbance and no further survey will be completed in these areas at this time. If future, land-disturbing projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.
#44: Giovagnoli Farm Property	Manchester	This 20-acre parcel contains a hay field and lies adjacent to the Cohas Brook. With its location next to Cohas Brook, it includes archaeologically sensitive lands. It will undergo preservation. NHDOT anticipates placing a permanent easement on this site.	The area is archaeologically sensitive and will undergo surface inspection to locate the visible archaeological features and record them on a minimal archaeological inventory form. Because the site is being preserved, there will be no land disturbance and no further survey will be completed in these areas at this time. If future, land-disturbing projects are identified in this area, all necessary phased archaeological survey will be completed in undisturbed locations.

Table 3.10-3 (continued)

Location / Name	Town	Description of Parcels	Level of Survey Completed/Recommended
# 46: Podsadowski Property (The Hill)	Manchester	This 34-acre parcel covers a steep forested hillside, which contributes to the groundwater recharge of Crystal Lake. Because of the steepness of the lands, the parcel is not archaeologically sensitive. It will undergo preservation.	Because of the steepness of the hillsides, the area is not archaeologically sensitive and archaeological investigations are unnecessary.
#53: Demers Property Easement	Manchester	This 10-acre conservation easement on undeveloped lands is intended to widen the ecological corridor along Mosquito Brook. The area has been disturbed by nursery operations or is wet. It will undergo preservation. The area does not appear to be archaeologically sensitive.	Because of the level of soil disturbance and extent of wetlands across the remainder of the parcel, the lands are not archaeologically sensitive and archaeological investigations are unnecessary.

3.10.4.1 Native American Archaeological Resources

Contexts

The Study Area is situated within the upper Merrimack River drainage. Investigations along the drainage have identified Native American sites ranging in age from the Early Archaic (10,000-7500 B.P. [before the present]) to the Late Woodland (1000-450 B.P.) period. Completed investigations in the project area identified Late (5000-3000 B.P.) and Terminal Archaic (3600-2500 B.P.) sites along the terraces of Cohas Brook, along small, unnamed streams, and adjacent to Canobie Lake and Cobbetts Pond; and a small wetland. The Woodland period (3000-450 B.P.) was also weakly represented along Cohas Brook. Investigations to date have not recognized occupations in the Paleo-Indian (12,500-10,000 B.P.), Early Archaic (10,000-7500 B.P.), and the contact period between Native Americans and Europeans dating after 450 B.P. To date, most of the identified remains are located along Cohas Brook where a dense pre-contact, Native American occupation exists. The function or use of many of these sites has yet to be determined. Identified functions to date include a possible fishing station, short-term campsite, and tool reduction workshop.

As evidenced by the large number of sites identified by the Phase IA and IB investigations, the Cohas Brook area appears to be a favored setting during the pre-contact period. Cohas Brook is a prominent waterway that joins the Merrimack River and Lake Massabesic. Its setting would have been favorable for pre-contact use and settlement with its high banks, well-drained sandy soils, and level terrace surfaces. The diversity of associated microenvironments would have assured multiple resources through all seasons. The locale offered the lacustrine environment of Lake Massabesic, the riverine environment of the Merrimack River, stable wetlands, a perennial stream, and a protected interior setting along Cohas Brook. Quartz sizable enough for tool manufacture may have been locally available in veins or outcrops near Lake Massabesic. Historically speaking, this area was well known for its anadromous fish, and this resource may have been utilized during the pre-contact period.

The occupations along the entire Cohas Brook drainage system span a long time period. Its Middle and Late Archaic components are well represented. The Dickey Plain Site and its associated components, 27 Hb 216 and 27 Hb 20, are prominent among these sites and together have yielded a large artifact collection for the Late Archaic period as well as a limited collection from the Woodland period. A diversity of tool types, including a cache of large blades, are found in this collection, and a number of volcanic stone materials can be visually distinguished. The site is situated on the west bank of the Cohas Brook near the confluence of other water resources that includes wetlands. This setting ensures access to multiple resources and may have served as a congregating place (Potter and Bunker 1991: 65-67).

The sites investigated in the I-93 median during the Phase IB testing by Potter and Bunker (1991) share a number of traits that firmly place them within the expected range of variation for the area adjacent to Cohas Brook in the northern end of the project area. They are all located on sandy, well-drained soils and have intact stratigraphy affected only by plowing. The distance from water extends up to 500 feet, but the sites are set on the sandy soils closest to surface water. The sites overlook either Cohas Brook itself or wetlands that drain the brook system. Similar tool materials were discovered at all the sites. A distinctive reddish-brown volcanic stone was found at the Dickey Plain Site Extension (27 Hb 216) that resembles the material used to manufacture the cache of blades found in the Marshall Collection. Several of the sites may be dated to the Middle to Late Archaic in the region. This tool material diversity is interpreted as an increasing dynamism that intensified through the Late Archaic as local populations grew and long distance contacts expanded.

Each of the eight sites discovered in the 1990-91 (27 Hb 17, 27 Hb 216, 27 Hb 20, 27 Hb 16, 27 Hb 15, 27 Hb 220, 27 Hb 219, and 27 Hb 218) have the ability to provide data for addressing research topics pertinent to the Cohas Brook and Merrimack Valley region. The sites offer well-preserved archaeological contexts that will facilitate data collection and interpretation. Information may be collected on Late Archaic trade, exchange, and communication within and beyond the area. Data may also be gathered on the specific nature of settlement along Cohas Brook. The relationship of site size and density as indicators of settlement duration, seasonality, population size, and distance of occupation areas from the main stream or large wetlands may be explored. The role of the individual sites as satellites or extensions of larger sites may be addressed. Artifact variation and tool material selection and its sources may be studied as keys to understanding the dynamics of the Late Archaic period.

Thus, if impact cannot be avoided, continued archaeological investigation of the Native American sites along Cohas Brook is recommended. The ability of Native American sites along Cohas Brook to produce data on the noted research topics would require investigation in a Phase II determination of eligibility study.

Four additional areas along the shoulder tested by PAL and retested by Bunker in 2003 contained Native American cultural materials (27 Rk 331, 27 Rk 333, 27 Rk 336, and 27 Rk 328). They appear to represent small loci of activity and contain varying quantities of lithic debitage, resulting from stone tool making. . The cultural affiliation of these four sites is not yet identified.

Identified Properties

A brief summary of the sites identified through Phase IB testing that will receive further, primarily Phase II testing after the completion of the FEIS study follows (see Table 3.10-1).

Dickey Plain Site Extension (II) (27 Hb 216) is located in Manchester on a small terrace along the Cohas drainage within the highway median The site yielded a high density of artifacts including hornfels, quartz, quartzite, chert, and volcanic stone flakes, biface fragments, edge tool fragments, cores, utilized cobbles, and bifaces diagnostic of the Late Archaic (Small Stemmed) (6,000-3,000 B.P.) and Terminal Archaic (Atlantic) periods (3600-2500 B.P.) . Evidence of a large tool workshop was present.

Dickey Plain Site Extension (III) (270 Hb 20) occurs on a flat terrace on the north bank of Cohas Brook in Manchester. A total of 65 quartz, volcanic, hornfels, and quartzite flakes; one biface base; one core; one edge tool fragment; and one biface fragment was found. A Carbon-14 (C-14) date within Late Archaic Period (6,000--3,000 B.P.) was recovered from the site. Because of the types of artifacts found and the location of the site in close proximity to Cohas Brook, the Dickey Plain III Site may have functioned as a fishing station.

Hayward Site (27 Hb 15) is located in Manchester in the vicinity of a small wetland. A quartz Squibnocket biface datable to the Late Archaic Period (6,000-3,000 B.P.), a quartz biface base, one volcanic biface midsection, one volcanic flake, and one hornfels flake were recovered. On the basis of these finds, the Hayward Site was probably a short-term campsite.

Owens Site (27 Hb 16) is located on a terrace of a wetland pond developed from a minor tributary of Cohas Brook in Manchester. The site included two quartz cores, three volcanic flakes, two quartz flakes, and one quartzite flake. No diagnostic tools or features were found and therefore no specific site age was identified.

Lovering Site (27 Hb 17) is located on a terrace of Cohas Brook near a minor tributary confluence in Manchester. The site contained three small, discrete loci of flaking debris. A total of 26 quartz and volcanic flakes, fire-altered rock, and a possible hearth feature were located. Although no diagnostic artifacts were found, the lithic materials recovered at the site correspond to other Late Archaic sites within the Merrimack River drainage. Other cultural periods may be represented.

Site 27 Rk 331 is located in Windham. A small locus of activity, the site measures approximately 30.5 m x 61 m in size, and is situated on a gently sloping terrace. A total of two quartz and three felsite flakes were recovered from the site. However, no diagnostic tools or features were found to adequately date the site.

Site 27 Rk 333 is situated on a low-lying terrace adjacent to a re-routed stream in Windham. A total of 88 pieces of quartz chipping debris was recovered within this site. Flake types found include 86 unmodified flakes, one utilized flake, and one shatter fragment. The high concentration of lithic debris from such a small area in two adjacent 50 x 50 cm test pits suggests a possible tool reduction workshop. Without diagnostic cultural materials or materials from which radiocarbon dates can be derived, the site is not datable.

Site 27 Rk 336 is located in Windham on a sloping terrace north of a small stream. The site appears to represent a small locus of activity. However, temporally diagnostic artifacts or features were found. A total of five quartz and two felsite flakes were recovered.

Site 27 Hb 218 is located west of Cohas Brook in Manchester. Lithic materials recovered from the site include one quartz biface tool fragment and two quartz flakes. The site is considered a small "find spot" since further testing around the area failed to recover additional cultural material.

Site 27 Hb 219 is situated adjacent to a small stream in the vicinity of Cohas Brook in Manchester. About fifty fragments of chipping debris were recovered from thirteen units at the site. Lithic materials include quartz, hornfels, felsite, and rhyolite flakes. In addition to the chipping debris, one felsite Neville biface fragment and one possible feature were found. Testing in 2003, recovered fire-cracked rock, 38 additional flakes, one Small-Stem point, one Neville point variant, and one feature with fire-cracked rock. The diagnostic projectile points indicate a Late Archaic occupation (6,000-3,000 B.P).

Site 27 Hb 220 is located east of a stream near Cohas Brook in Manchester. Eight test units yielded quartz, felsite, hornfels, jasper, and rhyolite flakes, and one biface fragment. The absence of diagnostic material did not permit attribution to a cultural period.

Site 27 Rk 328 is located in Salem along a primary tributary to Porcupine Brook. It has received some disturbance from previous construction activities along I-93. To date, testing has recovered one chert perforator /scraper and one clear, tertiary quartz flake. It appears to be a small campsite. Without diagnostic artifacts, it cannot be attributed to a cultural period.

3.10.4.2 Historic Archaeological Resources

Contexts and Site Significance in Historical Archaeology

The significance of historical archaeological sites is determined by weighing a number of considerations. These considerations include the finding of site significance under criterion D, which recognizes the importance of data that excavation of the site can provide to an understanding of the cultural development of the immediate property as well as to the historical context or contexts with which it is associated. The NHDHR maintains a listing of historical contexts significant to the cultural development of New Hampshire. The site must also possess sufficient physical integrity to convey this information and the level of integrity must be similar to or greater than other identified sites in the area that relate to the same context. In addition, the extent of documentary resources including oral tradition, written materials, maps, and other pictorial sources as well as associated standing buildings and structures that add to the understanding of the site and its related context contribute to the site's significance.

Historical archaeological resources as well as architectural historical resources often gain significance under similar historical contexts. However, along the Salem-Manchester project area, many of the contexts associated with the early communities of the area are represented only in the historical archaeological record. Those contexts established by the NHDHR for which the historical archaeological sites may gain significance include: Brick Making for Local and Regional Markets, 1650-1920; Logging, Lumbering, and Saw Mills, 1620-present; Early Exploration and Settlement in the Interior of New Hampshire, 1623-1770; Granite Quarrying and Stone Cutting, 1790-present; and Grain Farming and Grist Milling, 1650-Present; Mixed Agriculture and the Family Farm, 1630-present; and Pre-Automobile Land Travel, 1630-1920. These contexts are briefly noted with their associated historical archaeological sites below. The Architectural History Section (see Section 3.10.5-2) provides a brief description of the Mixed Agriculture and the Family Farm, 1630-present that is also a significant context for many of the sites that appear to be associated with a farmstead. The specific thematic associations of many of the historical archaeological sites still require determination.

Identified Properties and Associated Contexts

A brief discussion of the potentially significant historical archaeological sites located by the archaeological studies and their associated contexts follows. A complete list may be found in Table 3.10-1 and their locations are noted in **Figure 3.10-1**.

Following the Revolution, towns in the region began to develop craft-based industry such as small, water-powered mills that supplemented the agricultural economy. They provided goods primarily for local consumption with limited trade of surpluses. These industries included gristmills, sawmills, carding mills, tanneries, brickyards, and other light industries. Important mill locations included Beaver Brook in Derry Village, Kendall Pond in Londonderry, Spicket River in Salem Village

or North Salem, Policy Brook downstream from Canobie Lake north of Salem Depot, and along the millpond along Cohas Brook below the outlet of Lake Massabesic (Preservation Company [Project Area Form] 2002: 24).

Potter and Bunker conducted a Phase IA and Phase IB level study of a small, family-operated brickyard identified as the Dickey Road Brickyard site (27 Hb 18) near Cohas Brook. As population and the market expanded, brick making became a common local industry along the Merrimack Valley and locally in the Cohas Brook vicinity in the mid-nineteenth century. The area offered the necessary resources for the industry including a workable clay source, firewood to fuel the kilns, and a cheap labor force as well as a large market. The industry tended to be spatially mobile as clay beds became exhausted. Evidences that remained at this site include indications of kiln firing, brick discard, and a possible clay pit. Usually, few structural remains survive except perhaps for the brick floor associated with such a complex. Deed research suggests that it operated between 1845 and 1855 and was probably run by either the Dickey or McQueston family. All phases of brick manufacture probably occurred at the site (Potter and Bunker 1991: 45-47).

Also located along Little Cohas Brook, the Corning Mill site (27 Hb 19) received a visual and pedestrian survey in Phase IA and limited shovel testing during the Phase IB investigations. The survey located three partial stone foundations marking the site. Highway embankment fill may cover a portion of the site. A hand-drawn map of the area may show a sawmill in this vicinity. Small sawmills are noted along the watercourses of the area as early as the 1730s and continue in this area until the late nineteenth century. Deed research indicates that George Corning owned the Corning Mill by 1787, which may be this site, and that it was rebuilt in 1804. Use of the yard ceased between 1814 and 1836 (Potter and Bunker 1991: 53-55; Bunker and Wheeler 2003 [site 27 Hb 19]). Few sawmill sites dating to the 18th century are known, increasing potential significance of this resource.

The Boyer Lane Granite Quarry (27 Rk 364) represents the Granite Quarrying and Stone Cutting Context, 1790-present. The quarry site includes three flooded quarry pits and many fragments of hand-cut granite blocks and waste material. The form of the plug drill marks indicate that the quarrying activity post-dates 1830s. The quarry probably operated into the late nineteenth century, and is said to have produced stone for St. Joseph's Church in Salem and the City Hall in Lawrence, MA (Preservation Company 2002: 16 [Fairmont District Area Form]; Garvin 2001: 45).

Although the Indian Rock Road Dam Site (27 Rk 365), which now stands at the outlet to a small pond, may have significance as a dam that powered a small industrial site, the structures and historical context with which it was associated need to be clarified through further testing.

An agricultural economy developed across much of the project area at the time of settlement in the early 18th century and continued into the early twentieth century. Archaeological sites clearly identified to date relate to the Mixed Agriculture and the

Family Farm, 1630-present context. The early economy of the region was based on semi-subsistence agriculture. The soil was generally productive for crops of grasses for livestock feed including corn and oats. Marshes became important natural sources of feed hay. Livestock included horses and cows. Surplus livestock and crops were marketed in the developing settlements. Scotch-Irish Derry farmers also produced flax. Turnpikes were built across the region in the opening years of the nineteenth century and the Merrimack River became navigable by 1807. Old County Road, later known as Honeywell Road, is an early road along a portion of the corridor in the Town of Windham. It was established by the mid-eighteenth century and was abandoned in the 1960s. It is a gravel lane about 15' wide with stone walls and ditches along both sides (Bunker and Wheeler 2003 [H4-38/40/47-28]). Several of the sites in the project area that are associated with farmsteads were located near this corridor. These corridors permitted the movement of goods, and the growth of industry provided local and regional markets for agricultural surplus. Area farms prospered from this trade.

The arrival of the railroads at mid-century also facilitated the long-distance transportation of agricultural goods to the developing industrial cities. However, the hauling of goods to the rail centers continued to occur on local roads such as Old County Road. Mixed farming was practiced through the mid-nineteenth century. Milk and cream were used for home consumption, and butter became the primary cash dairy product. A small number of farm families also made cheese. Swine, cattle, and sheep were kept for meat and wool production. Primary plant crops included corn, potatoes, oats, hay, rye, barley, and beans. Fresh products from apple and peach orchards, small truck farms, diary and poultry farms with supporting feed crops of hay and corn gained importance in the late nineteenth and early twentieth century. However, by the second half of the nineteenth century, area farms had begun to contract in number and size. Except for small pockets such as the Armenian farming communities, many of the orchards and poultry farms disappeared from the area between the 1920s and 1940s (Preservation Company [Project Area Form] 2002: 23-52). The sites of the farmsteads and sections of old County Road corridor may gain significance together as a district representing the following contexts: Pre-Automobile Land Travel, 1630-1920 and Mixed Agriculture and the Family Farm, 1630-present.

A discussion of the sites of farmsteads identified along or near Old County Road follows (Bunker and Wheeler 2003, Preservation Co. 2002). The John Dinsmore Site (27 Rk 7) and the W.A. Dinsmore (27 Rk 367) sites are part of the Old County Road Complex of sites in the Town of Windham. Dating as early as 1811, the John Dinsmore Site, occupied by the grandson of the original settler, Robert Dinsmore, includes a cellar hole with chimney base, cistern, well, and one or two outbuilding depressions, which may represent a barn and blacksmith shop. Although abandoned by 1920, the house and barn continued to stand until at least 1949. The cellar hole is lined with stone capped with sill stones, and a massive, interior stone chimney pile is located in the rectangular cellar hole depression. (Potter and Bunker 1991: 55-64). The W.A. or John Dinsmore Site contains a stone-lined cellar hole with charred structural remains within it, other architectural debris, and a collapsed hearth. The later site dates prior to 1857. This study area was originally located within a large, 2,800-acre parcel owned

and settled by Robert Dinsmore beginning in ca. 1741. The date of the original land grant to Dinsmore is not known. Some of this area remained in the family as late as 1892. Dinsmore participated in the early government of the area, serving as one of three commissioners organizing the newly established Town of Windham. William Dinsmore, his son, inherited the location of these sites in a 1400-acre tract in 1751.

The W. Parker Homestead (27 Rk 368) and O. Parker House (27 Rk 369) are also along or near the Old County Road corridor in the Town of Windham. The W. Parker Homestead includes a partial foundation of cut granite of sufficient size for a barn. The site was owned by W. Parker by 1857 and occupied by the Misses Dinsmores by 1892. The buildings remained standing in 1961 and was destroyed by the construction of 1-93. The O. Parker House included a filled cellar hole with disturbed foundation and a stone-lined well. The site was occupied by 1892 and abandoned by 1953.

Along with several part-time crafts including carpentry, blacksmithing and coopering practiced within a farmstead setting, farming remained the primary occupation of the residents along Old County Road. The area was a small farm neighborhood during the nineteenth century. These rural neighborhoods had geographic boundaries, were characterized by inhabitants that shared similar cultural backgrounds, and were maintained by a spirit of cooperation in areas ranging from road maintenance, exchange of tools and machinery, assistance during illness, and additional special services and agricultural tasks. Members of one family settled four of the farms by 1811. Edward Searles purchased much of the area between 1901 and 1917. By the early 1960s, only two houses remained along Old County Road.

Located well north of the currently identified corridor for Old County Road, the L.H. Corthell Farmstead (27 Rk 370) in Londonderry includes a stone house and separate barn foundation and nearby well. Testing recovered 2,560 18th and 19th century artifacts from the site to date. Mapping suggests the farmstead was established between 1857 and 1892 and occupied as late as 1941. Located just north of the Corthell Farmstead in Londonderry, the G.W. and O.W. Crispin Homestead (27 Rk-371) includes a cellar hole with partial foundation visible and possible outbuilding location. This site was present by 1857, and the buildings were removed by the turn-of-the-century. Construction in the 1960s along I-93 has probably destroyed the associated house foundation. Testing has uncovered a small number of artifacts to date. The Stonehenge Road Farmstead (27 Rk 372) includes two small stone outbuilding foundations and a barn foundation. I-93 probably occupies the site of the house. The site was occupied by 1857, and identified as a blacksmith shop in 1892. However, a majority of the artifacts and some of the construction material at the site appear to date from the 20th century. Further testing would identify the date and function of the remaining foundations as part of the determination of significance.

Already selected as a wetland mitigation site, a minimal Archaeological Inventory Form has been completed for the South Road Foundation site at the South Road Mitigation Site in Londonderry. The site included a residence that was extant by

1857, when it was known as the C. Alexander House, and remained standing until at least 1969.

3.10.4.3 Archaeological Resources Conclusions

Determinations of eligibility for the National Register of Historic Places were not made for either the Native American or historical archaeological resources within the project area. Such determinations will be made during the final design phase. The identified resources listed in Table 3.10-1 that will be impacted by the Selected Alternative would receive further study under the standard method established by NHDHR for archaeological investigations.

Because of current site disturbance along the corridor, further testing and archival research may find that at least several of the sites listed in Tables 3.10-1 are not eligible for the National Register. However, further research is needed to pinpoint what these remains represent. Supplemental investigations will be conducted at several sites to determine if sufficient remains are present to conduct a Phase II evaluation. These supplemental investigations involve testing at 4 m intervals around the locus of the find and, in some cases, additional documentary research to identify artifact density, the presence of features, and the approximate site boundary. These sites include: 27 Rk 336, 27 Rk218, 27 Rk 331, 27 Rk 372, and 27 Rk 328. All other impacted sites in Table 3.10-1 will receive a Phase II subsurface testing to determine if the site is eligible for the National Register of Historic Places. In addition, locations of wetland creation and park-and-rides containing sensitive areas will undergo Phase IB intensive investigation. Phase II testing at potentially eligible sites entails the exposure of horizontally larger areas of the identified site through 1 X 1 meter or larger units, usually adjacent to features identified during Phase IB. Included in this study would be the further development of the historical and Native American contexts associated with the resource, additional site specific research, and a comparative study of the subject site with others in the region associated with similar contexts to determine whether the former possesses an equal or greater site integrity and ability to provide information on the shared context or contexts.

If those resources found eligible for the National Register of Historic Places and impacted by the Selected Alternative cannot be avoided, then redesign to avoid adverse effect would first be considered. If redesign would not possible or practicable, a determination of the need for preservation in-place versus data recovery would be made. Based on experience with archaeological resources in New Hampshire, it is considered unlikely that preservation in-place would be necessary and that satisfactory mitigation can be achieved through Phase III data recovery. If data recovery would be deemed necessary, it would be completed in accordance with the Secretary of the Interior's Standards. The research design for the data recovery includes significant research questions that may be addressed through the site's excavation. The information gained from these investigations provides

significant data not only about that site but the cultural context and associated sites to which the subject site relates.

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3.10.5 Historic Architectural Resources

3.10.5.1 Methods and Procedures

Survey

All work was done in accordance with the methodology created to identify historical and architectural resources, adopted by the New Hampshire Department of Transportation, the New Hampshire Division of Historical Resources, and the Federal Highway Administration in October 1991. The methodology used to identify archaeological resources is addressed separately in Section 3.10.3.

The I-93 Improvement Project Area includes the eighteen-mile portion of I-93 in southern New Hampshire between the Massachusetts border at Salem, extending north through the towns of Salem, Windham, Derry, Londonderry to the southern part of the City of Manchester, terminating at the intersection of I-93, I-293 and NH101. There are five interchanges between these points, numbered Exits 1-5, south to north.

Historic resources were examined at three levels, shown on three different maps. The largest area was examined in the Project Area Form, which covered an approximately one-mile-wide area centered on I-93. A smaller area of an approximately 1000-foot swath centered on I-93 was examined in more detail in the Windshield Survey. The smallest examination area was the project impact area, where individual historic resources were considered in depth.

Initial work was done to form a large-scale overview for understanding contexts in which to identify individual historic resources. Then a Windshield Survey was conducted using the Project study area maps, which covered an area on each side of the eighteen-mile long I-93 corridor. Every property over fifty years old was identified and photographed as part of this effort. This information was brought by Preservation Company to several in-depth meetings of the Determination of Eligibility (DOE) Committee consisting of New Hampshire Department of Transportation (NHDOT), New Hampshire Division of Historic Resources (NHDHR), Federal Highway Administration (FHWA) and project engineers to determine exact project impacts on the resources that had been identified in the Windshield Survey. When these were determined, in-depth survey was conducted for those properties using either a reconnaissance- or intensive-level inventory form. The level of survey was determined in coordination with the DOE Committee based on a judgment of integrity of the potential resources. Historic Districts were recorded on NHDHR Area Forms.

The Project Area Form was prepared to provide context for the review of individual properties. It covers a larger area than the Windshield Survey, encompassing village centers and historic areas near the I-93 corridor and along the major cross roads; it is approximately one mile wide, centered on I-93. Photographs were taken of notable and representative properties and historic areas or villages located in the vicinity of I-93. Photograph locations are shown on the base map, created from USGS topographic maps.

The Project Area Form relies heavily on the considerable previous work done in area towns (most of it by Preservation Company, author of the current I-93 Project Area Form), so much of the information was excerpted from previous reports. These sources include the Salem Townwide Area Form, Windham Townwide Area Form and Project Area Form prepared 1991-1992 by Monroe, Hill and Federer for the Route 111: Windham-Salem Project, and the Area Form prepared for the Salem Depot project by Lisa Mausolf in 1998. In 1986, a townwide survey of Derry was conducted by Lynne Emerson Monroe, for the Derry Historic District Commission and Historical Society, that served as the basis for the Historic Resources chapter of the Derry Master Plan, which included Patricia Neil's "Developmental History of Derry, New Hampshire." In 2001, Preservation Company completed a Derry Townwide Area Form and individual survey forms for properties along Route 102 in West Derry for the Exit 4: Derry-Londonderry Project. In 1993, Preservation Company completed in Londonderry, the "Airport Access" or Bedford-Manchester-Londonderry, F-042-1(1), 11512 Project. Lynne Emerson Monroe and Kari Ann Federer of Preservation Company completed a Scoping Report, a Londonderry Townwide Area Form (1995), a North Londonderry Historic District Area Form, and survey forms for individual properties impacted by the project. A city-wide windshield survey of Manchester was conducted in 1991 by Lisa Mausolf, for the City Planning Department. This survey divided the city into some forty-three areas, which were addressed on NHDHR Area Forms. Areas E24, E25 and E26 are in the current study area.

Survey numbers and boundaries of individual properties and historic districts that had previously been determined eligible for the National Register in the above projects were shown on the Project Area map. Existing National Register listings were also indicated.

Historic properties located within the project impact areas were individually surveyed and shown on project base maps. The project impact area is defined by a band approximately 500 feet on either side of the existing northbound and southbound lanes, with a minimum width of 1,000 feet. At interchanges the area extends to each side of the existing I-93 rights-of-way approximately 2,000 feet along the connecting roadways. New "park-and-ride" facilities are planned at Exits 2, 3, and 5, and properties in those areas were also surveyed.

A total of thirty-eight properties and potential five historic districts (containing twenty-two individual properties also surveyed individually) were surveyed as part

of this undertaking (Table 3.10-4). Three districts and nine individual properties were determined eligible for the National Register of Historic Places. In addition, six individual properties and a historic district in the project area had previously been determined eligible for the National Register. All are listed below:

Table 3.10-4
List of Properties and Districts

Survey Number	Tax Map/ Parcel	Address	Type of Form	Notes/Description	Eligible Acreage	Eligibility
SALEM						
SAL0201	135/9359	38 Cross Street	Front	early 20th century gable front		not eligible
SAL0202	135/9362	32 Cross Street	Full	early 20th century gable front		not eligible
SAL0203	135/8922	25 Cross Street	Front	barn converted to apartments		not eligible
Area SAL-D1	maps 141 and 134	Salem Street	District	Armenian Settlement Historic District	105.08 acres	eligible (A)
SAL0204	127/8919	19 Cross Street	Full	Kinzler House	5.79 acres	eligible (A)
SAL0205	126/4160	4 MacGregor	Full	one small house in "Mac" subdivision, cabbage farm		not eligible
Area SAL-D2	map 97	Fairmont Road	Area	Fairmont Road Potential Historic District		not eligible
SAL0206	97/4424	20 Fairmont Road	Full	ca. 1920 Reynolds House, gambrel		not eligible
SAL0207	97/7865	33 Fairmont Road (Boyer Lane)	Full	20th century Craftsman, stone foundation		not eligible
SAL0208	97/4415	19 Fairmont Road	Full	early 20th century house		not eligible
SAL0209	97/4416	21 Fairmont Road	Full	early 20th century cape		not eligible
SAL0210	97/4423	22 Fairmont Road	Full	early 20th century gable front		not eligible
SAL0212	97/4426	8-10 Fairmont Road	Front	ca. 1920 Fairmont House, large, 2-family		not eligible
SAL0213	97/4414	2 Point A Road	Front	ca. 1907 Square House, Thomas House		not eligible
SAL0214	97/4413	4 Point A Road	Front	ca. 1920, small with front bay		not eligible
SAL0215	97/4412	6 Point A Road	Front	ca. 1917 McMaster House, hip roof, stone work		not eligible
SAL0216	97/4410	26 South Policy Street	Front	ca. 1924 Bungalow, hip roof, chicken house		not eligible
SAL0217	97/4409	28 South Policy Street	Front	ca. 1942 stone foundation, flat-roofed garage		not eligible
SAL0218	97/4408	30 South Policy Street	Front	ca. 1922, vernacular with porch		not eligible
SAL0219	97/3948	29-31 South Policy Street	Front	Policy Brook Farm, Hagopian Farm		not eligible
SAL0211A and SAL0211B	97/7851	27, 25 Pelham Road	2 Fronts	2 mid-20th c. capes on one parcel		not eligible
SAL0220	87/7441	70 Brookdale Road	Full	late 19th century cape with barn		not eligible
SAL0221	87/7507	63-65 Brookdale Road	Front	early 20th century cape		not eligible

Table 3.10-4
List of Properties and Districts

Survey Number	Tax Map/ Parcel	Address	Type of Form	Notes/Description	Eligible Acreage	Eligibility
SAL0222	87/7504	61 Brookdale Road	Front	early 20th century Bungalow		not eligible
WINDHAM						
Area WND-D1	12-A	off Searles Road	District	Searles Castle Historic District	95 acres	eligible (A, B and C)
WND0200B	22-B-31	115A South Shore Road	Front	early 20th century cottage on Canobie Lake		not eligible
WND0200A	22-B-31	115 South Shore Road	Full	20th century split level on Canobie Lake		not eligible
WND0202	17-G-20	82 Range Road	Full	Colonial Revival cape		not eligible
WND0084	17-G-40	85 Range Road	continuation sheet	previously surveyed property: Sally Park House		not eligible
WND0085	17-G-26	86 Range Road	continuation sheet	previously surveyed property: George F. Armstrong House (Common Man Restaurant on lot)	1 acre, part of parcel that abuts Range Road and includes the house	eligible (C)
WND0086	17-G-30	88 Range Road	continuation sheet	previously surveyed property: Robert Armstrong House	0.82 acres	eligible (C)
WND0203	11-C-5	3 Wyman Road	Front	Ranch with rubble stone foundation and chimney		not eligible
WND0206	11-C-125	30' off Indian Rock Road on old Route 111	Full	Indian Rock, 6 feet tall	rock footprint + 10' radius	eligible (A through Criterion Exception F)
WND0033	17-J-80	Indian Rock Road	continuation sheet	previously surveyed George Dinsmore Craftsman style (stone) house	1.1 acre	eligible (C)
WND0205	2-A/600	117 North Lowell	Full	19th century connected farmstead		not eligible
DERRY - no individual or district present in project area						
LONDONDERRY						
LON0115	10/147	7 Reo Lane	Front	former telephone switching building		not eligible
Area LON-D1	map 10	Pillsbury Road	District	Woodmont Orchard Historic District	196 acres	eligible (A)
LON0102	10/58	6 Buyck Lane	Front	camp		not eligible
LON0116	10/00	Ash Street	Full	Ash Street Bridge, ca. 1961, AKA Robert Prowse Bridge (designer)	bridge footprint and approaches	eligible (C through Criterion Exception G)
LON0114	13/21	79 Stonehenge Road (corner of Perkins)	Full	Reed Paige Clark Homestead, Stonehenge house, ca. 1844	114.4 acres	eligible (A, C)
LON0110	13/23	16 Perkins Road	Full	ca. 1780 cape, no outbuildings		not eligible
LON0111	12/96, 13/22, 24-4	22 Perkins Road	Full	ca. 1944 cape w/stone chimney and foundation, barns and coop		not eligible

Table 3.10-4 (continued)

Survey Number	Tax Map/ Parcel	Address	Type of Form	Notes/Description	Eligible Acreage	Eligibility
LON0113	16/1	48 Perkins Road	Full	ca. 1790 cape w/mid-20th century porch		not eligible
LON0155	16/3	62 Perkins Road	continuation sheet	previously surveyed Greek Revival sidehall		not eligible
LON0080	15/54	79 Perkins Road	continuation sheet	on corner of Route 28, previously surveyed Atwood/Plummer House		not eligible
Area LON-D2	map 16	Route 28/ Rockingham Road	District	Meadow Estates Potential Historic District		not eligible
LON0103	16/43	99 Rockingham Road	Full	shed-roofed ranch, ca. 1952, Shepard House	9 acres	Individually eligible (C)
LON0104	16/94	111 Rockingham Road	Full	ranch, ca. 1942-47		not eligible
LON0105	16/88	117 Rockingham Road	Full	ranch, ca. 1955, Gearty House		eligible (C through Criterion Exception G)
LON0106	16/84	121 Rockingham Road	Full	ranch, ca. 1955		not eligible
LON0107	16/82	118 Rockingham Road	Full	ranch, ca. 1955, Raiche House		not eligible
LON0108	16/86	114 Rockingham Road	Full	ranch, ca. 1952		not eligible
LON0117	16/93	113 Rockingham Road	Full	ranch, ca. 1952, Moody House	1.4 acres	individually eligible (C)
LON0109	16/90	112 Rockingham Road	Full	ranch, ca. 1957		not eligible
MANCHESTER						
MAN0010	812/0002	2081 Bodwell Road	Full	stone house, Clark House	35.17 acres	eligible (C)
MAN0011	832/19	759 Corning Road	Front	mid-20th century cape		not eligible
MAN0012	832/18	769 Corning Road	Front	mid-20th century cape		not eligible
MAN0013	832/17	781 Corning Road	Front	moved, mid-20th century cape		not eligible
MAN0014	832/16	787 Corning Road	Front	gable-front converted camp		not eligible
MAN0020	832/15	805 Corning Road	Front	converted camp		not eligible
MAN0015	832/14	849 Corning Road	Front	converted camp		not eligible
MAN0016	0826/0005	718 Bodwell Road	Front	converted camp		not eligible
MAN0017	0826/0007	730 Bodwell Road	Front	converted camp		not eligible
Area MAN-D1	826/0009	Cohas Avenue	District	Manchester Low Service Pumping Station	54.5 acres + 1 rod on north side of Cohas Brook	eligible (A, C)
MAN0019	0612/0001	539 Brickett Avenue	Front	altered cape with barn		not eligible

Determination of Eligibility

The intensive level survey information was deemed sufficient to determine significance and eligibility for the National Register of Historic Places. The Determination of Eligibility (DOE) Committee, comprised of representatives from NHDOT, NHDHR, and FHWA, met on February 13 and 27, 2002. All final determinations of National Register eligibility were made by consensus. The resulting Determination of Eligibility forms for each eligible property that is potentially impacted within the project area are on file with each agency and included in Appendix G.

The criteria (36 CFR Part 60) by which National Register eligibility is determined are:

Criterion A: Resources that are associated with events or trends that have made a significant contribution to the broad patterns of our history.

Criterion B: Resources that are associated with the lives of persons significant in our past.

Criterion C: Resources that embody the distinctive characteristics of a type, period or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguished entity whose components may lack individual distinction.

Criterion D: Resources that have yielded, or may be likely to yield, information important in prehistory or history.

To be eligible for inclusion, resources must also retain integrity, defined as the quality of location, setting, design, materials, workmanship, feeling and association sufficient to clearly convey a property's history and significance.

Criteria Consideration F for commemorative properties states that a property can be eligible if design, age, tradition or symbolic value has invested it with its own significance. Criteria Consideration G states that properties less than fifty years old may be eligible if of exceptional significance.

There are no properties in the study area currently listed on the National Register of Historic Places. During this study, eleven individual properties and four historic districts were determined eligible for listing on the National Register of Historic Places.

3.10.5.2 Historic Context of Study Area

The following narrative is taken from the Project Area Form completed in 2002. Additional text on the significance of the architectural development of the area is available from NHDOT and NHDHR.

Definition of Study Area

Interstate 93, I-93 (also known as the Alan B. Shepard Highway between the Massachusetts line and Hooksett, New Hampshire) is the primary route north from Boston, through Lowell to the cities of Manchester, Concord and points north. The I-93 Project is defined by the Interstate corridor, beginning at the state line just north of Methuen, Massachusetts, passing through the southeastern New Hampshire towns of Salem, Windham, Derry and Londonderry, terminating at the I-293 interchange southeast of downtown Manchester.

Interchanges along I-93 intersect with the region's primary west-east highways. These include Routes 97 (Exit 2) and 38 in Salem. In Windham, Exit 3 is located at Route 111. The Derry exit (Exit 4) is located just over the Londonderry town line, west of West Derry. This interchange with NH Route 102, which passes southwest-northeast through West Derry and Derry Village. This State route was established between Hudson and Derry in 1915, and from Derry to Raymond in 1919. Exit 5 is located in the northern part of Londonderry where the Interstate crosses Route 28. Immediately to the east on Route 28 is Wilson's Crossing and northwest of Exit 5 off of Route 28 is the village of North Londonderry. The north end of the Project Area is I-293, which connects NH Route 101, the primary east-west road through the state, with U.S. Route 3 and the F.E. Everett Turnpike, which run south-north along the west side of the Merrimack River.

The historical development of the region was directly linked to its central location between major industrial cities, Manchester, Nashua, Lowell, Lawrence and Haverhill. Transportation routes from various periods of the area's development, parallel each other, running southeast-northwest. All were superceded in importance by the Interstate when it was completed in the study area in 1963.

As new transportation corridors were established, village centers developed along them, often resulting in a complete shift in emphasis within each town.

The earliest north-south route was the Merrimack River to the west of the study area. The early highway along the west bank of the river later became U.S. Route 3. Parallel to it is the F.E. Everett Turnpike built in the 1950s.

The first major through-road was the Londonderry Turnpike, built in 1806, it extended from Lowell to Concord. The Turnpike, a straight road running southeast-northwest, survives as NH Route 28 through Salem and Windham, and as Bypass 28 from Derry north. It continues north through Auburn, east of the Study Area. Derry

Village developed as the "Lower Village" around the Turnpike and mills on Beaver Brook. It reflected a shift in the town center from the older village of East Derry or the "Upper Village." The old turnpike fell into disuse later in the nineteenth century, but was rebuilt as a state road in the 1930s.

Another important early south-north route was Mammoth Road, built in 1831 from Lowell to Manchester, passing through Londonderry, just west of the study area. The new road became the focus of Londonderry's small town center. Mammoth Road now forms NH Route 128 through Londonderry, passes through North Londonderry village, and continues as Route 28A northerly into the eastern part of Manchester.

During the second half of the nineteenth century, the railroad played a major role in the region's development patterns. The Manchester and Lawrence Railroad, which opened in 1849, is now abandoned. It is located east of I-93 through much of the study area, crossing to the west in Londonderry and continuing into Manchester. The railroad paralleled the west side of the old Turnpike through Salem, and gave rise to a new village center, Salem Depot, west of the early town center. Near the Derry town line, Windham Depot developed as a small center around the junction of the Manchester and Lawrence and a second line, the Worcester, Nashua and Portsmouth Railroad, running southwest-northeast. The Manchester and Lawrence ran diagonally through the southwest corner of Derry, and the focus of activity in the town shifted west again to what became West Derry, or Derry Depot. In Londonderry, villages developed on the rail line at Wilson's Crossing and North Londonderry, where the rails intersected Mammoth Road. The line continued north into Manchester, west of the study area. Manchester was the junction of the Concord and Montreal Railroad, which ran parallel to the Merrimack River. The Concord and Portsmouth Railroad runs west-east from Manchester north of the study area.

NH Route 28, which was replaced as a south-north through road by the Interstate, was improved in the early twentieth century as a State highway connecting Lawrence and Manchester. It is located along the old Turnpike through Salem Depot and Windham, east of the study area. In Derry, Route 28 turns west and north through the center of West Derry. The highway continues north as Rockingham Road curving through Londonderry, past Wilson's Crossing, under the Interstate and northwest to North Londonderry. It follows a bypass segment built in the 1950s, past North Londonderry. Route 28 follows the historic route of Mammoth Road a short distance north and then veers northwest onto South Willow Street. The path of Mammoth Road, north into Manchester, is Route 28A. Bypass Route 28 follows the path of the old Londonderry Turnpike, east of I-93 through Derry Village and north.

Historical Background

1719-1740: Settlement and Growth, Agriculture and Small-Scale Industry

Prior to permanent European settlement in the area, the lands along the east side of the Merrimack River were known as Nutfield for the abundance of chestnut trees found by the earliest travelers to Amoskeag Falls (Hazlett 1915; Willey 1896). As

early as 1622 grants were made along both sides of the Merrimack, first by the Penacook Indians and the royal government in England and later by the provinces of Massachusetts and New Hampshire. Most were never occupied, but confusion over titles and boundaries lasted for many years (Blood 1948; Browne 1902; Clarke 1875; Monroe and Federer 1993).

During the early Colonial period, the territory included in the study area was claimed by both Massachusetts and New Hampshire. The battle over the southern boundary of the latter state was not resolved until 1740. During the seventeenth century, New Hampshire was annexed periodically to Massachusetts, making the southern boundary unimportant. However, in the early 1700s, as New Hampshire began to assume its own identity under the leadership of Governor John Wentworth, the quarrel over the boundary precipitated the final separation of New Hampshire from Massachusetts and initiated the settlement of "second tier" towns in the southern third of the state. In an attempt to strengthen New Hampshire's claim to land in the Merrimack valley, Wentworth used his ability to charter towns. However, Massachusetts' governor Belcher did the same. The race to solidify land claims through town charters began in 1722 with New Hampshire's incorporation of Londonderry, originally called Nutfield. Massachusetts retaliated in 1725 by granting the town of Rumford (now Concord) to the north.

The original town of **Londonderry** encompassed what are now Derry and Londonderry, as well as Windham and parts of Manchester and Salem. **Windham**, taking its name from a town in Ireland, was set off from the southern part of Londonderry in 1741. During the same period, the southern portion of Salem, at the southern edge of the study area, was at first a part of Haverhill, Massachusetts, and in 1735, it was included in the new town of Methuen, Massachusetts. After the state boundary dispute was finally resolved, **Salem** was incorporated in 1750. In 1752 the southeastern portion of Windham was added to Salem. The northern part of Londonderry was set off in 1751 as Derryfield, later known as **Manchester**. **Derry** remained part of Londonderry until 1827.

European settlement in Nutfield (**Londonderry**) actually began in 1719. The settlers were Scotch-Irish Presbyterians who emigrated from Londonderry, Ireland, in 1718. They were descendants of Presbyterians who fled religious persecution in Scotland in 1612. Following a century of conflicts with the native Catholic Irish, a group determined to seek religious freedom in the New World. Five boatloads left Ireland in the spring of 1718 and arrived in Boston three months later (Londonderry Historical Society 1979:I). Various congregations who had come with their ministers dispersed.

Those led by Rev. James MacGregor sought available land for settlement and eventually selected Nutfield. Sixteen families arrived there on April 17, 1719, along with Rev. MacGregor (Derry Historic Research Committee 1977:4). Temporary cabins were erected and a common field cleared and planted on West Running Brook. By the fall of 1719, close to fifty-four families had arrived (Hurd 1882:565). The group petitioned Massachusetts and then New Hampshire for incorporation as a

township, and in 1722, the twelve square mile territory became the Town of **Londonderry**, named for the Irish city from which most of the settlers had come. The first meetinghouse was constructed between 1720 and 1722 in what became Londonderry's first village center, now East Derry. Rev. James MacGregor preached there until his death in 1729 (Historical Booklet Committee 1969:16; Hurd 1892:177).

Land was laid out in a series of divisions. Home lots were sixty acres each; the second division lots were forty acres, selected as an amendment to make up for what each home lot was lacking (Hurd 1882:567; Monroe and Federer 1994). The first division in December 1719 was the Double Range, in which long, parallel home lots were laid out on either side of West Running Brook in what is now **Derry** (Beckley and Watts 1975:28; Hurd 1882:567; Monroe and Federer 1995). The second and third divisions, made in the early 1720s, were the "English Range" in the northwest corner of the present town of Derry and "Aiken's Range" to the south of it. The "Three-quarter Mile Range", in which ownership remained controversial for many years, occupied the north central part of Derry (Beckley & Watts 1975:31, 32, 35, 47). Ayer's (or Eayer's) Range was on the eastern edge of what is now Londonderry, but the settlers built their houses on the eastern ends of the lots in Derry. The area that developed as the present town of **Londonderry**'s village center was laid out ca. 1728 as the High Range (Londonderry Historical Society 1962b:42). The rest of Londonderry was laid out in large irregular tracts of less valuable land, given in the second division amendment and highway lands in the 1730s (Hurd 1882:569; Monroe and Federer 1995).

The initial colonists were joined by steady infusions of new immigrants arriving from Northern Ireland. At the same time, English settlers from Massachusetts moved northward into the Merrimack Valley in increasing numbers. Settlement in the region was spurred by the needs of the colony for more land and by the desire to protect unclear claims to land along the Merrimack River (Monroe and Federer 1993).

In an early attempt to claim land on the River, John Goffe Jr. and his two brothers-in-law, all relatives of Londonderry colonists, settled near the mouth of Cohas Brook in 1722. They were the first settlers in what would become **Manchester**, and established saw and grist mills in the vicinity later known as Goffe's Falls. In 1729, to maintain claim to land at Amoskeag Falls, three men from Londonderry settled near what would become downtown Manchester. (Eventually English colonists, rather than the Londonderry Scotch-Irish, received title to the land at Amoskeag when Derryfield was chartered in 1751) (Monroe and Federer 1993).

Windham was laid out as part of Londonderry in the 1720s. The first settlement occurred southeast of Cobbetts Pond on Copp's Hill. Land in the Range between Canobie Lake and Cobbetts Pond was laid out in 1728. It was divided into 21 long, narrow strips averaging fifty acres. Residents of Londonderry were given land as an amendment to earlier divisions. Range Road was laid out in 1739, and many large and productive farms were established in the mid-eighteenth century. A number of them remained in the same families for generations (Morrison 1883:45, 160).

The region's early economy was based on subsistence farming. The soil was generally productive for crops of grasses for livestock feed, Indian corn and oats. Livestock included horses and cows, and the meadows (marshes) were of great value as a source of feed hay. The Scotch-Irish were the first in North America to cultivate the white potato, an important staple crop (Hurd 1882:567).

The Scotch-Irish were also the first to engage intensively in household manufacturing of linen. They brought flax seed, spinning wheels and looms with them from Ireland, and as soon as the land was ready, they cultivated flax, which was considered among their most valuable produce. Londonderry was soon well known for its high grade of linen throughout the colonies (Derry Historic Research Committee 1977:4; Monroe and Federer 1995).

Londonderry's limited water power was utilized by the grist and sawmills, which were necessary corollaries to agriculture. The first were built in 1719 on Beaver Brook at what became **Derry Village**. In 1721, six men received the right to build a dam and sawmill on Aiken Brook, creating Horne Pond, now within **West Derry**. The first mill in present day **Londonderry** was built in 1731 on Beaver Brook at what is now Kendall Pond. Another early mill was operated by David McAfee at the later site of Manter's Mills in the northeast corner of Londonderry (Historical Booklet Committee 1969:11-12; Hurd 1885:571; Parker 1851:86-87).

The earliest roads and settlement patterns followed routes oriented toward the falls at Amoskeag. Many of the principal roads were laid out in the 1720s. The route from the mills at **Derry Village** to Amoskeag Falls was laid out in 1724, along Old Derry Road and Bodwell Road. Kendall Pond Road dates from 1723. East Pillsbury Road was the original road between the **Londonderry** center and **Derry** Village. The section of road between what are now Derry Village and West Derry was laid out in 1737, as was a road connecting Derry Village and what would become North Londonderry. The main east-west road through Londonderry (now Stonehenge and Litchfield Roads) was built in 1744 (Monroe and Federer 1994; Hurd 1885:570; Derry Historic Research Committee 1977:4). A path along the east bank of the Merrimack (now Route 3A/Brown Avenue) was in existence as early as 1734 (Hurd 1885:577).

Londonderry grew rapidly and by the 1730s the town (including at that time the present towns of Londonderry, Derry, Windham and part of Manchester) accounted for one-tenth of New Hampshire's population (Parker 1851:316).

Settlement of **Salem** began in the 1730s as people from Haverhill and Methuen moved northward seeking grazing lands. The center of settlement was at what became Salem Village (Gilbert 1907:47, 84). A road from Salem Village to what would become Salem Depot was first laid out in 1737 (Main Street, Route 97). The Messer's Crossing area in the southeast corner of Salem was also the site of early settlement. What is now Hampshire Road and Pond Street, across the south edge of Salem, was laid out in 1735 (Mausolf 1998).

1740-1806: East and West Parishes of Londonderry, Windham and Salem Incorporated, Population Growth

By 1740, Londonderry's population was large enough that the western part of town was set off as a separate parish. The East Parish, covering most of **Derry**, retained its meetinghouse at East Derry. The West Parish encompassed all of present **Londonderry** and a small part of Derry. It was incorporated through the petition of some forty families living in the western part of town where a meetinghouse had been built a few years earlier. The division was made partly because of the distance to the church in the eastern part of town, and partly because of dissatisfaction with the East Parish minister, Reverend William Davidson. Reverend David MacGregor, son of the town's first minister, served as the first pastor of the West Parish. Because some East Parish families also preferred Rev. MacGregor, the General Court allowed forty residents of each parish to be members of the other. For years, some families traveled miles to church, passing each other on their way. This practice ceased in 1778, just after MacGregor's death (Parker 1851:93; Beckley and Watts 1975:170). The original meetinghouse in the West Parish was located on Hardy Road. Londonderry's oldest burying ground, the "Cemetery on the Hill" is located nearby.

Windham was set off from Londonderry and incorporated as a town in 1741. **Salem** contained about seventy-five scattered homesteads when it was incorporated in 1750 (Gilbert 1907). A part of Windham was annexed to Salem two years later. The boundaries between Londonderry and Windham continued in flux for the next fifty years, as parts of Londonderry were exchanged, until a final determination was made in 1805.

Manchester was chartered as Derryfield in 1751. It developed slowly as the land was considered poor for agriculture. Fishing and the potential water-power of the Merrimack and its tributaries were the impetus for settlement. Villages developed at Goffe's Falls, Amoskeag and Piscataquog. The partial paths of Mammoth and Bodwell Roads were in place by this time, and the original Manchester center developed on what became Mammoth Road, in the southeast corner of the current urban core, northwest of the study area. A meetinghouse was built there in 1758 (Mausolf 1991).

In 1769, both East and West Parishes of **Londonderry** began construction of new meeting houses. The eastern one is still extant in East Derry. The western church, which was not completed until the 1780s, was placed more centrally, near "Hardy's Corner" at the intersection of Pillsbury and Gilcreast Roads. It was located on the western edge of the Project Area, west of Woodmont Orchards. The Valley View Cemetery was established nearby. (In 1845 the building was moved west and remodeled to become the Londonderry Town Hall) (Historical Booklet Committee 1969; Monroe and Federer 1995).

During the end of the 18th century, following the American Revolution, towns in the region began to develop small water-powered industries, supplementing the

agricultural economy. These included gristmills, sawmills, tanneries, brickyards, and other light industry. Beaver Brook at **Derry** Village and Kendall Pond in **Londonderry** were important mill sites. In **Salem** sawmills, gristmills, carding mills and shingle mills were located along the Spicket River in Salem Village and what would become North Salem. For a time, mills operated on Policy Brook, downstream from Canobie Lake, north of what became Salem Depot. The first cotton mills were established at the Amoskeag Falls in **Manchester** in the 1790s. Various industries operated on the "Mill Pond" on Cohas Brook below the outlet of Lake Massabesic.

In the late eighteenth century, **Londonderry** received an influx of a number of families from Ipswich, Massachusetts who were of English Puritan descent. Londonderry (still including Derry) became the second largest town in New Hampshire, with 2,389 residents in 1767, and 2,590 in 1775. At that time, **Salem** had a population of 1,084, while **Windham's** was 529. **Manchester,** which remained primarily a rural, agricultural community at this time, grew slowly from 285 people in 1775 to 362 in 1790 (Bureau of the Census 1909). **Londonderry**'s population continued to rise slowly, but steadily to 2622 in 1790, 2650 in 1800, and 2766 in 1810 (Parker 1851:316).

1806-1847: Londonderry Turnpike, Stage Coach Era, Town of Derry Incorporated

The early 1800s were an era of prosperity, aided by improved transportation networks. The Merrimack River became navigable in 1807 with the construction of a canal around the Amoskeag Falls at **Manchester**. Increasing amounts of produce and lumber were transported by canal boats to the growing manufacturing centers of Lowell and Lawrence, and to Boston via the Middlesex Canal.

The region was even more strongly impacted by the 1806 opening of the Londonderry Turnpike, which now forms the western edge of the study area. It became the most direct land route (sixty-three miles) between Boston and Concord, which officially became New Hampshire's capital in 1808. The road was designed to be as straight as possible, between Concord to the state line, where it connected to the Essex Turnpike of Massachusetts. The Turnpike passed diagonally through the towns of **Windham** and **Salem**. This east-west division of the towns, changed their development and foreshadowed future transportation in a north-south direction along this corridor. New industries developed to support travel on the turnpike, including stage lines, taverns and blacksmith shops. A toll gate was located in Salem north of Canobie Lake near what is now the intersection of Routes 28 and 111 (the toll house was demolished ca. 1880) (Morrison 1975:164). A tavern was located nearby to the south (Gilbert 1907). In **Derry**, a new village developed on the Turnpike and by the 1820s had replaced East Derry as the town center (Monroe 1986). Derry Village became a center of trade, through which large quantities of lumber, pork, butter and eggs, and all the surplus of the farm were transported, and the location of carding, fulling, saw and shingle mills. **Manchester** had not yet begun to develop as a major industrial site and the Turnpike bypassed it on the east.

The Amoskeag mills soon changed the history of the region. In 1810, the Amoskeag Cotton and Wool Factory was incorporated. In 1828 it was purchased by a group of Boston investors who had recently established mill towns at Lowell and Lawrence. They soon laid out mills, canals and housing that became the core of downtown **Manchester**. The name of the town was officially changed from Derryfield to Manchester in 1810. As of 1830, Manchester had a population of 877. By the 1840s, Amoskeag and other textile mills employed more than 5,000 people.

In 1827, due to its size and population, the large town of **Londonderry** was divided in half. The eastern part, although it was the older section of town, received a new name when it was incorporated as **Derry** on July 2, 1827. The western half retained the name Londonderry (Hurd 1892:168). As of 1830, Londonderry had a population of 1,467, while Derry had 2,178. At the same time, **Windham**'s population peaked at nearly a thousand, while **Salem** had 1,302 residents (Bureau of the Census 1909:19). Over the next twenty years, Derry's population decreased (1,850 in 1850), while Londonderry's increased (1,731 in 1850). While East Derry remained the location of Derry's Town meetinghouse, Derry Village developed on the Turnpike. Its expansion included the construction of businesses, and the Congregational and Methodist churches.

In 1831, the history of the region was impacted by the construction of another new road, called Mammoth Road. The new route between Concord and Boston ran due north-south through **Londonderry**, superceding the Turnpike through Derry as the route for stagecoaches and transport of farm produce to Lowell and Boston. Traffic was diverted from the Turnpike and its proprietors turned the road over to the towns in 1838. Small population centers developed on the new road, including what would develop as the **Londonderry** town center. A tavern and livery stable and store were located in this area. In 1837, Mammoth Road became the location of the new Presbyterian Church. In 1845, the old meetinghouse was moved nearby and remodeled as the Town Hall. A Methodist Church was built in 1856 (Beckley and Watts 1975:170, 177; Hurd 1882:580). North Londonderry was the location of White's Tavern and store. A stage coach rest stop and mail transfer point was located on Mammoth Road (Route 128) at the corner of Nashua Road (Route 102), at Shephard's or Plummer's Tavern (now the Homestead Restaurant) (Beckley & Watts 1975:25). Mammoth Road runs due south-north through the geographical center of **Manchester**, passing east of the present urban core. It passed through what was then Manchester Center (north of the intersection of Mammoth and Island Pond Roads), but which soon declined in importance as the downtown area began to develop. The southeast corner of Manchester remained a rural area. In 1840, residents of the vicinity established the Stowell Cemetery on Bodwell Road. The District 9 schoolhouse was located at the corner of Bodwell and Corning Roads (Mausolf 1991).

Improved roads and the proximity of growing industrial cities allowed area farmers to prosper. Better transportation also facilitated the beginnings of the shoe industry through the outwork distribution system. Small shoe shops were located throughout the towns in the study area. The first larger shoe shop in the Area was built in 1830,

by the Manter family who already had a prosperous sawmill in the northeast corner of **Londonderry**. Shoes were shipped to Boston by river and canal boat. Barrels were made in nearby cooper shop and were shipped by sea to Cape Cod for fish packing (Londonderry Historical Society 1972:134).

1847-1870: Railroad Era, New Villages Develop, Agricultural Prosperity, Amoskeag Mills, Shoe Industry

The end of the stagecoach era in the region began with the construction of the Concord and Nashua Railroad in 1838, replacing Mammoth Road in importance as a north-south route (Hurd 1885:577; Parker 1851:314). The study area was directly impacted by the construction in 1847-49 of the Manchester and Lawrence Railroad (soon taken over by the Boston and Maine, becoming the Manchester and Lawrence Branch), connecting the two rapidly growing manufacturing centers. The railroad meant the end of the turnpike as the primary travel route. Railroad stations became centers of new development and in several cases replaced older town centers.

In **Salem**, the railroad ran parallel and close to the west side of the Londonderry Turnpike (now Route 28). Just below the town line in Methuen was Messer's Depot, near the major road intersection known as Messer's Crossing. The location of Salem's depot, east of the older town center, gave rise to a new village Salem Depot. The area expanded dramatically after 1860 and became the town's commercial and industrial center. The extant railroad station was built in 1867 on the north side of Main Street, and the freight depot (also extant) stood farther north between the railroad and the turnpike (Route 28). Various industries and businesses were soon built nearby. Public buildings included the Methodist Church on Pleasant Street. The "Old Stone Schoolhouse" on the west edge of the village, corner of North Policy and Main, served the community from 1825 to 1873 (Mausolf 1998).

In **Windham**, the turnpike and railroad forked at the head of Canobie Lake. While the turnpike continued toward Concord, passing through Derry Village, the railroad headed northeast toward Manchester. Windham's depots were located near the Turnpike junction and near the northern edge of town. The railroad passed through the western part of **Derry**, about a mile and a half west of the old Turnpike, along a route chosen for its more level topography (Historical Booklet Committee 1969:26). The railroad formed the core of a new village, Derry Depot or West Derry, which soon replaced the older villages as the town center (Monroe 1986). The **Londonderry** railroad station was located in the northern part of that town where the line crossed Mammoth Road, just south of White's Tavern. A village grew up around it known as Londonderry Depot or North Londonderry. A second depot was located to the east, at what became known as Wilson's Crossing, and a post office opened there in 1862 (Monroe and Federer 1994). From North Londonderry, the railroad headed north into **Manchester** through undeveloped land that later became the edge of the Manchester Airport.

The railroad initially benefited area farmers, as much of what was produced was exported to the nearby industrial cities to feed the booming populations (Monroe and

Federer 1995). Mixed farming was practiced through the mid-nineteenth century. Milk and cream were used for home consumption, but butter was the primary cash dairy product. A small number of farm families also made cheese. Swine, cattle, and sheep were also kept for meat and wool. Primary plant crops included corn, potatoes, oats, hay, rye, barley, and beans. By this period, flax was no longer grown in Derry. Fewer than 25 percent of area farms had orchards at this time (Bureau of the Census 1850). Harvey P. Hood, whose dairy would play a major role in the history of **Derry**, took advantage of railroad access to Boston, when he established a dairy farm there in 1848 to supply his Charlestown, Massachusetts milk route. Over the course of several years, Hood amassed a 320-acre farm in the center of Derry between West Derry and Derry Village (Neil 1986).

The textile factories in **Manchester** expanded rapidly in the mid-nineteenth century changing the face of the region. As of 1850, Manchester had a population of 13,932. In 1860, the population was 20,107. At that time, a third of Manchester's residents were foreign born, mostly Irish. Due to building restrictions in the city center, people seeking less expensive building lots selected sites on the outskirts of the city. One of the small villages that developed was known as "Hallsville," located at the southeast corner of the urban center, northeast of the I-93/I-293 Interchange.

The shoe industry was introduced during this period, through outwork production for factories in nearby Massachusetts cities (Derry Historic Research Committee 1977:19). Small shoe shops were located on farms throughout area towns. The first larger shoe factory in **Derry** was built near the Depot in the 1850s. At Wilson's Crossing in **Londonderry**, shoes were hand-stitched at Richardson's shoe factory from the 1850s. To the north off Old Derry Road, the Manter shoe factory employed twenty men and twenty women in 1860, manufacturing 22,000 pair of shoes a year (Bureau of the Census 1860). The first shoe factory in **Salem** Depot was established in 1856 by Prescott Hall who played a major role in the development of the village (Mausolf 1998).

As new transportation and industries developed, **Derry**'s population fluctuated from 2,034 in 1840 to 1,850 in 1850 and 1,995 in 1860. With migration west and to industrial cities, rural **Windham**'s population decreased to only 753 in 1870. **Londonderry'**s peaked in 1850 at 1,731 and declined to 1,405 by 1870. **Salem**, with a stronger industrial base, was able to maintain its population, increasing steadily to 1,603 in 1870 (Bureau of the Census 1909).

1870-1900: Shoe Industry, Derry Depot, Salem Depot, Amoskeag Mills Expand, Population Boom, Specialized Farming

The shoe industry was responsible for the rapid growth of West **Derry** during the last decades of the nineteenth century. The advent of steam power allowed industries flexibility of location, and the railroad corridor was the most convenient for transportation. In 1870, Col. William S. Pillsbury, who had been manufacturing shoes in Londonderry, purchased the older factory at Derry Depot and established what would become the W.S. and R.W. Pillsbury company (Derry Historic Research

Committee 1977:25). Wood products, barrels and boxes, were a secondary industry. Derry Depot (West Derry) grew rapidly as a busy downtown, the focus of business activity in the town. Broadway was lined by large commercial blocks by the end of the nineteenth century. The shoe industry was also a major factor in **Salem** Depot's development. Hall's shoe shop was enlarged and the F.P. Woodbury Shoe Company was established in 1880.

In **Londonderry**, steam power was installed at Richardson's shoe factory at Wilson's Crossing. About 1870, the factory employed twenty-five men and seven women. Its success was short-lived however, and the factory was not rebuilt after it burned in 1880. Manter's factory remained in business, and about 1865, Manter employee and in-law J.M. Platt built a new shoe factory nearby. The building burned ten years later and the business was relocated to a nearby blacksmith shop. Workers could be housed in a nearby twenty-room boardinghouse. Manter's grist mill closed down in 1868, while the sawmill continued on a reduced scale until ca. 1890 (Londonderry Historical Society 1972). North Londonderry, on the eastern edge of the study area, also became a small industrial site, with businesses near the railroad depot. A shoe factory was established there by G.F. MacGregor in 1868, and was converted to steam power when it was taken over by Corning in 1875. In 1878, Annis Grain and Lumber company was formed and it soon operated a gristmill, lumber business and general store near the railroad depot. Nearby was the Fessenden Stave and Heading Manufacturing where some forty men were employed (Monroe and Federer 1995). North Londonderry grew into Londonderry's largest village, with several stores, mills, railroad station, and a neighborhood of residential side streets. During the same period, Londonderry's public buildings and churches in the town center were also updated.

In 1872, a second rail line, the Nashua to Rochester Railroad was built, passing southwest-northeast through **Windham** and continuing through the corner of Derry. Near Windham's northern town line, its junction with the Manchester and Lawrence Railroad became a small village known as Windham Depot, with store, grist and sawmill located near the railroad station.

In **Manchester**, the Amoskeag Mills expanded and absorbed other factories. In the 1870s Amoskeag employed more than 4,000 and another 5,000 worked at smaller, associated textile mills. Shoe factories also operated in the city, including Kimball Brothers Shoe and Hoyt Shoe in East Manchester established in the 1880s and 90s. In the 1890s, the city's population topped 50,000.

Londonderry, like other agricultural towns in the region, suffered population losses after the Civil War, declining steadily to a low of 1,220 in 1890. Then, as local industries expanded, it rebounded to 1,408 by 1900. **Derry** experienced little growth in the mid-1800s, but increased rapidly from 1,809 people in 1870 to 2,140 in 1880, then boomed to reach 3,583 by 1900. **Salem** grew to 1,809 in 1880 and 2,041 in 1900. **Windham's** population continued to shrink, reaching 632 in 1890 (Bureau of the Census 1940).

In the late nineteenth century, fresh products in demand in urban markets became increasingly the focus of area farms. Fresh milk, collected in cans and shipped from the depot, became a more important cash product. Poultry began to replace other livestock in importance during this period. Crops of hay and corn remained important for animal feed, but grains were imported from the West by rail. Horses replaced oxen as draft animals. Market gardening to raise fresh vegetables for the nearby cities increased in importance. Orchards of apple trees, and to a lesser extent peaches, became a major component of all farms in this area where the soil was well suited for them (Bureau of the Census 1880). The H.P. Hood Company was a major outlet for dairy farms in the region, shipping around 20,000 quarts of milk to Boston each day from facilities at **Derry** Depot, as well as producing butter and cheese (Derry Historic Research Committee 1977:181).

However, during this period, many area farms were abandoned as residents went to work in the growing factories. Remaining farmers supplemented their incomes by taking in summer boarders. In **Londonderry**, boardinghouses included the Laurels in North Londonderry, and Echo Farm (burned 1916) at Wilson's Crossing.

The area's lakes and ponds became attractive to tourists and tourism became a major part of the region's economy. Crystal Lake had been a popular local swimming hole since the mid-nineteenth century (Mausolf 1991). At the outlet of Massabesic Lake in **Manchester** was the Mill Dam Hotel (Hurd 1892). The northern shore of the Lake developed as an upscale retreat with the Massabesic Hotel, accessed by the Concord and Portsmouth Railroad (Mausolf 1991). Canobie Lake in **Windham** and **Salem** became a destination and recreation point for city people. Visitors came to stay at boardinghouses for summer vacations and summer residences were built near the lake shores. In the 1890s, three of Windham's twelve boardinghouses were located on Range Road on the ridge between Canobie Lake and Cobbetts Pond. They included Lakeview Farm, "Bella Vista" and the Johnson family's Highland View Farm. The historic farms stretched between the two bodies of water and property owners began erecting summer cottages on the lakes at either end. The first cottage on Cobbetts Pond was built in 1886. It was followed by many more in the 1890s. The owners of "Bella Vista" established a cabin colony known as "Camp Bell" at the northern end of their land, on the south shore of Cobbetts Pond. On the northwest side of Canobie Lake, cottages were built beginning in the 1880s on "Johnson's Point" by the Johnsons of Highland View Farm. The cottages were rented for many years, then sold into private hands in the 1950s (Monroe and Federer 1992).

It was the railroad that allowed large numbers of people to travel to summer homes and for day-trips at lakefront attractions. A railroad station was built in 1885 at the north end of Canobie Lake in **Windham** near the intersection of the old Londonderry Turnpike (Route 28) and Range Road (Route 111). This became known as Canobie Lake Depot, and a village by the same name grew up nearby, including a store and post office, blacksmith's shop and several residences. Residents of Lawrence, Methuen, Haverhill, and even Boston came to Canobie Lake Village by train and

were transported by horse and wagon to local boarding houses and cabins. Dance halls and recreation areas were established on the lake shores. The largest of these was Policy Pond Grove or Granite State Grove, which was established on the north shore of Canobie Lake in the 1850s and greatly expanded in the 1880s. The Grove included boat rentals, bowling alleys, a dance hall, cook house, shooting gallery, and skating rink (Town History Committee 1975:94, 64).

The late nineteenth century was also marked by the rapid development of technology. A large fire in **Manchester** in 1870 was the impetus for establishing the Manchester Water Department. The City built reservoirs and a pumping station in the eastern corner of the city beginning in 1872. Lake Massabesic was the water source. A dam and a canal were located at the southwest corner of the lake; they fed a pumping station located on the west side of Cohas Avenue. A force main ran over 7,000 feet from the pumping station to the reservoir at the junction of Island Pond Road, Cohas Avenue and Mammoth Road, and gravity fed water from this reservoir to the city.

In **Derry**, a telegraph line was installed between the three villages in 1877. In 1882, a telephone line connected Derry Village and Derry Depot (Hurd 1892:176). The Derry Electric Light Company was formed in 1891 and a power plant established in West Derry on Horne's Pond. Downtown sections were electrified first and the process was not completed in rural areas until about 1930. The first power in Londonderry was generated by Merrill of North Londonderry in 1907, and that whole town was electrified by 1932 (Schmidtchen 1977:5).

A new mode of transportation, which would have a significant impact on the tourist industry, was introduced in the 1890s. The Chester and Derry Railroad was chartered in 1891, but construction was not completed until 1896. East of the study area, it began at the railroad station in **Derry** Depot, ran east through Derry Village, on to Beaver Lake, and through to Chester. Trolleys were timed to connect with B&M trains, and the cars carried considerable freight and mail from the depot (Historical Booklet Committee 1969:27-28).

1900-1920s: Streetcar Era, Summer Tourism, Industrial Peak, Commercial Development and Civic Activity, Road Improvements

The streetcar era peaked in the early 1900s. An electric railroad connecting Manchester and Derry was proposed as early as 1901 and opened in 1907. The Manchester and Derry Railway ran from south of Goffe's Falls in southern **Manchester**, over land to North **Londonderry**, then paralleled Mammoth Road south for about a mile, before turning east through woods and fields and to the railroad depot in **Derry**. For much of its history, hourly service was provided on the route, seven days a week (Cummings 1960:20, 28). The streetcar allowed Derry and Londonderry residents to commute to work in Manchester, brought tourists out of the city to Beaver Lake in Derry, where the Chester and Derry Electric Railroad opened Beaver Lake Pavilion in 1901 (Schmidtchen 1977:13). The City of **Manchester** built a bathhouse and a swimming beach on Crystal Lake. The first bathhouse was

erected in 1919. The existing structure was built by the Civilian Conservation Corps (C.C.C.) in 1939-41 (Mausolf 1991).

The **Salem** Division of the Massachusetts Northeastern Street Railway was built between 1900 and 1903, with fifty-six miles of track connecting Salem with Haverhill and Nashua. The trolley lines came from Lawrence and Methuen in the south, parallel to the west side of South Policy Street, and from Nashua and Lowell in the west, overland between Pelham Road and Route 38. They converged in the southwestern part of Salem Depot near the intersection of South Policy Street and Raymond Avenue. From there, a branch continued to a terminus on the southeast edge of Canobie Lake. The main line ran east on Main Street (Route 97) toward Haverhill. The 1902 car barn is extant on Main Street. The convergence, known as "Point A Station," was the largest trolley crossing in southern New Hampshire. In the vicinity were a waiting station, Heaps' Store and a small hotel known as the Fairmont House, which operated during the early 1900s.

In 1902, the Northeastern Street Railway opened Canobie Lake Park, on the southeast shore of the Lake in **Salem**, creating an attraction and destination point (Turner and Noyes 1975:92, 213). (It was one of a number of amusement parks operated by street railway companies, including Paragon Park in Nantasket, Horn Pond in Woburn, Pine Island Park in Manchester, and Willand Pond in Somersworth.) The new park replaced Granite State Grove in importance after the latter was destroyed by fire in 1909. Another recreational destination was Rockingham Park built in **Salem** in 1905 by a group of New York promoters, who hoped to make Salem part of the grand circuit of racetracks. They purchased the land, laid out the track, erected grandstands and paddocks. However, when the State outlawed gambling in 1906, the group suffered severe financial losses (Mausolf 1998).

Besides the large recreation spots, a great deal of building took place in the first half of the twentieth century, when seasonal cottages were constructed along the shores of Cobbetts Pond and Canobie Lake in **Windham** and **Salem**. By 1912 there were some seventy cabins on Cobbetts Pond (Town History Committee 1975:68). In 1903, the Armstrong family, owners of the Sally Park House (WND0084), the George F. Armstrong (WND0085) and Robert Armstrong (WND0086) Houses, and large tracts of surrounding land (much of it now covered by I-93), began to subdivide their land on the northwest shore of Canobie Lake. A road was built from Range Road at the Thom/Dinsmore House to the Lake and some thirty lots were laid out along West Shore Road. Buyers were from Lawrence and Methuen. By 1906, six cottages had been built and five more were in progress. Another thirty lots were offered for sale in that same year. Later, the owner of the George F. Armstrong House (WND0085) opened a beach with bathhouses, picnic grove and refreshment stand on his land at the northeast end of Cobbetts Pond. In the 1920s, John Evans from Lawrence created Bella Vista beach and dance hall, which became popular with day-trippers, on Cobbetts Pond on land associated with the Moses Haseltine House (Monroe and Federer 1992). Development of South Shore Road in Salem began in the early 1900s.

During the early 1900s, the character of the town of Windham, and Salem as well, was strongly influenced by the residency of eccentric millionaire Edward F. Searles. Born in 1841, Searles rose from work as a bobbin boy in the mills of Methuen, Massachusetts, to become a prominent interior designer in New York. His marriage to the widow of San Francisco magnate Mark Hopkins, gave him a quarter share of the Southern Pacific Railroad upon her death in 1891. With this inheritance Searles indulged his passion for medieval architecture. His estate at Stillwater Manor on World's End Pond in **Salem** (southeast of study area) was begun in the 1890s. In 1905 he built Searles Castle in **Windham** which became his primary residence. These and other important buildings in Windham and Salem were in collaboration with eminent Boston architect Henry Vaughan. The Castle is located in the study area, on the northeast side of the Exit 3 interchange (determined eligible under the Windham/ Salem 10075 Project). To the east on Route 111 is the Searles School and Chapel (listed on National Register). Searles amassed a vast amount of property (several thousand acres) between his estates. At one time he owned the entire territory north of Canobie Lake, and reportedly could drive the twenty miles between Methuen and Windham without leaving his property. He contributed large amounts of money to local towns. Numerous examples of stone work are found throughout the town of Windham, as indication of the influence of the materials and mode of construction used by Searles and Vaughan (Monroe and Federer 1991b).

Improvement of area roads for automobile travel began in the early 1900s. The earliest north-south highway to be developed through the region was the central trunk line established by the State in 1907 along what is now Route 3 on the west side of the Merrimack River. State improvements to other highways soon followed. In 1904 the old Londonderry Turnpike, from Messer's Corner to **Salem** Depot, was "macadamized" with funds donated by Edward F. Searles. Local factory owners Woodbury and Tenney funded work north to the **Windham** line (Mausolf 1998). A major reconstruction of the Londonderry Turnpike took place in 1914. These segments of the old Londonderry Turnpike became part of State Route 28, which was created in 1913-15 (numbered in the early 1920s) as a south-north highway from the Massachusetts line north to Manchester (Turner and Noyes 1974:102). Route 28 turned off the old Turnpike in Derry and the segment to the north remained essentially abandoned. NH Route 102 was established between Hudson and Derry in 1915, and from Derry to Raymond in 1919. Sections were straightened in the 1930s. The Town of Londonderry began improvements to Mammoth Road in 1917 (Monroe and Laprey 2001; Schmidtchen 1977:13-14).

The area prospered through the first quarter of the twentieth century, due to the nearby manufacturing centers of Nashua, Manchester and Lowell, which provided employment, a steady need for produce, and a supply of manufactured goods. As of the 1910s, the Amoskeag mills in **Manchester** were at the peak of operation and success, employing as many as 17,000 workers (Monroe and Federer 1993 1992). The City's population topped 70,000 in 1910 and peaked in 1920 at 78,384 (Bureau of the Census 1940).

This was the height of **Derry**'s shoe industry. Several large factories were built and occupied by a series of companies, whose financial successes appear to have been short-lived. Derry Depot contained the Pillsbury shoe factory, Perkins & Hardy Shoe, Derry Shoe Company, V.H. Moody Shoe, Emerson Shoe and Woodbury Shoe. Wood products also remained important. **Derry**'s population continued to increase from 3,583 in 1900, to 5,123 in 1910. West Derry grew as a commercial center, with the construction of new commercial blocks, as well as a new Town building. Manufacturing continued at **Salem** Depot (Turner and Noyes 1974:147). During the same period, small-scale local industries declined and Seavey's sawmill in **Windham** Depot was demolished (Town History Committee 1975:17). The larger Annis Grain and Lumber Company in North **Londonderry** remained prosperous and rebuilt its complex after a series of fires in the early 1900s. Londonderry's population grew again, to 1,533 residents in 1910 (Monroe and Federer 1995).

Agriculture remained the focus of the economy in the outlying areas of all study area communities. In **Derry**, the Hood Company continued operations after Harvey P. Hood's death in 1900, and dairy farming for fresh milk production remained important to area farms. During the same period, apples became the principal crop throughout the region, particularly in **Londonderry**. Originally part of the "Baldwin belt," named for the apple variety that became popular in northeast Massachusetts and southern New Hampshire in the late nineteenth century (Folger and Thomson 1921: 33-34), the impetus for orchard expansion in Londonderry was the introduction in 1900 of a new variety of apple, the McIntosh, which was developed in Canada and became popular for its excellent flavor and color. The apple industry in Londonderry was introduced when Rosecrans Pillsbury, owner of the Pillsbury shoe factory in Derry, publisher of the Manchester Union and operator of a large dairy farm, planted the McIntosh orchards now known as Woodmont Orchards, located on the west side of I-93, north of Exit 4. Londonderry's other major orchard, Moose Hill Orchards was established about the same time by Wallace Mack (Schmidtchen 1977:10; Monroe and Federer 1995). The industry flourished with the introduction of refrigerated storage in 1915 at Woodmont Orchards. Beginning in the 1910s, dairy farms were converted to orchard production. Apples were marketed mainly in New England, though exports to Europe were common in the 1920s and 1930s (Schmidtchen 1977:11). Cider mills were located at West Derry and North Londonderry.

On Range Road in **Windham**, a large orchard was established by the Dinsmore family (on the north side of Range Road, southwest of I-93). It contained 4.5 acres of apple trees, two acres each of peaches and pears, as well as grapes. Fruit was shipped by rail from Windham to Lawrence. On the south side of Range Road, on land extending to and beyond present I-93, the Thom/Dinsmore House property was operated as a huge pig farm from the 1890s to the 1920s. Hogs were butchered nearby in Salem and the meat shipped by rail to Boston from Canobie Lake Station. The Johnson family operated a large dairy farm at Highland View Farm on Range Road, and had a milk route in Salem. What is now Nassar's Orchard on the east edge of the study area in Windham was also established during this period.

Poultry farming also increased, often combined with orchard production and market gardening. One poultry farm and market garden in the study area was that of Ferdina and Albina Cote whose family created a small neighborhood known as Coteville near the Derry-Londonderry line. The Cotes moved from Nashua and purchased a house on twenty-four acres in 1904 (Schmidtchen 1977:232; Monroe and Federer 1995). In the study area in **Salem,** a large poultry farm was located at 92 Cross Street. The immigration of Armenian farmers into the section of south Salem along Salem and Cross Streets heralded the explosion of the market gardening or "truck farming" era in that town. These typically large and industrious families cleared significant amounts of land on both sides of these streets and successfully grew large quantities of vegetables for sale locally and in the nearby factory cities of Haverhill, Lawrence and Lowell (Turner and Noyes 1974).

1920s-1950: Automobile Era, Decline of Industry and Farming, Summer Home Tourism

By the 1920s, the automobile had replaced the railroad and the trolley as a means of transportation. The Manchester and Derry Railway, which was never a financial success, closed in 1926, and the Derry and Chester line ceased operation in 1928 (Neil 1986). The last streetcar on the Salem Division ran in 1929. Railroad travel also came to an end. The Manchester and Lawrence remained in operation on a reduced scale. By the 1920s the Wilson's Crossing station was no longer in use and the building was moved to North Londonderry to replace its depot which had burned. The Worcester, Nashua, and Portland Division of the Boston and Maine, passing through Windham Depot shut down in 1934 (Derry Historic Research Committee 1977:69). Passenger service was offered on the Manchester and Lawrence once a week on Sundays until 1953. Limited freight traffic continued into the late twentieth century.

Highway construction became increasingly important to the region. In **Salem**, Route 28 was widened somewhat in 1931-32 and became four lanes in 1950. In 1937-38, a portion of the old Londonderry Turnpike in **Derry** (which had fallen into disrepair and disuse, was repaired and reopened by the Works Progress Administration). The increased mobility allowed area residents to commute farther to work expanding opportunities for employment.

Automobile-related businesses increased, with service garages, filling stations, auto showrooms, and roadside dining establishment appearing with more frequency. Following World War I, Rockingham Park was used periodically for automobile and motorcycle racing. When gambling was legalized again in 1933, Rockingham Park returned to horse racing and became one of the State's largest sources of revenue. Motels, trailer parks and restaurants were built in the vicinity to serve workers and visitors to the track (Mausolf 1998). Canobie Lake Park was sold at auction and reopened under private ownership in 1932. A new parking lot for 5,000 cars opened off North Policy Street (Seed and Khalife 1996:53).

The automobile also allowed large numbers of families to establish small lakefront vacation homes. The shores of Beaver Lake and Island Pond in Derry, Canobie Lake

and Cobbetts Pond in Windham and Salem, and Crystal Lake in Manchester became densely settled with small cottages during this period. Farm boardinghouses had become less popular and all in the area closed during the 1920s. Cottage owners came primarily from southern New Hampshire and northeastern Massachusetts. At the same time, the region's industrial prosperity came to an end. The closing of the Amoskeag mills in **Manchester** in 1936 had a considerable impact on the area. After peaking in 1920, Manchester's population declined and hovered around 77,000 during the next two decades. In West **Derry,** the shoe industry continued on a reduced scale, with various companies operating for short periods. Derry's population fluctuated in the low 5,000s through this period. The village of West Derry continued to grow as a commercial center and numerous new public buildings were constructed, including a library, Masonic Temple, Veterans' Memorial building, and Post Office. **Salem** Depot also grew with the construction of public buildings including St. Joseph's Church in 1929. As a whole, Salem continued to grow slowly from 2,318 in 1920 to 3,267 in 1940. In North **Londonderry**, the Fessenden lumber yard and stave mill employed some thirty people as of the 1930s, but all other local industries had closed by this time (Schmidtchen 1977:9). Londonderry's population fluctuated between 1,300 and 1,400. **Windham**'s population reached a low in 1930 of 538 and then returned to its late nineteenth century size, topping 600 by 1940 (Bureau of the Census 1940).

The number of farms in the area continued to decline. On Range Road in **Windham**, the fruit farm of the Lake View House was largely abandoned after the 1920s. The pig farm at the Thom/Dinsmore House closed. By the 1940s, dairy farming had ceased on all but the Johnson's Highland View Farm. Several farmers operated vegetable farms and had roadside stands during this period (Monroe and Federer 1992). In **Salem,** the small Armenian market farms continued to prosper, though profits began to be impacted by the competition brought on by the refrigerated transport of produce from such other agricultural regions as the Midwest and California. The H.P. Hood Company sold its farm in **Derry** in 1938 after the demand for certified milk dropped. During the same period, poultry farming increased. A large egg grading and auction facility opened in West Derry in 1934, drawing business from all over New England. Mixed farming and truck farming continued on a reduced scale through the mid-twentieth century. From **Salem** farms, fresh milk was delivered to the nearby cities of Methuen and Lawrence, Massachusetts (Turner and Noyes 1974:158). Orchards in **Londonderry** continued to expand modestly through World War II, though the European export business of the 1920s and 1930s disappeared during the war years, dramatically reducing international profits (Schmidtchen 1977: 10-11).

Another form of transportation, the airplane, had nearly as great an impact on the history of the region as the automobile. In 1927, Smith Field was established by the City of Manchester (Monroe 1991). In 1940, as World War II escalated, it was taken over by the military, an airbase rapidly constructed and renamed Grenier Field (Monroe 1991).

1950-Present: Highways, Commuting, Residential Development

During the second half of the twentieth century, the development of the area continued to be directly tied to regional transportation routes.

Communities in the study area grew at unprecedented rates, due to the construction of several major highways and the growth of the technology industry in nearby Nashua and the Mass. Route 128 and I-495 beltway areas in Massachusetts. West of the study area, the F.E. Everett Turnpike (parallel to older Route 3, along the west side of the Merrimack), opened between Manchester and Nashua in 1955. Construction of Interstate 93 began in 1961, and the opening of the highway in 1963 was the single-most influential event in the twentieth century development of the region. The high speed road replaced older routes between the cities of Lowell, Manchester, Concord and points north, and brought southern New Hampshire within an easy drive of Boston. New Hampshire's favorable tax rate and the region's proximity to Massachusetts brought extensive new settlement, which resulted in a boom of new building to accommodate the increase in population. Area towns became "bedroom communities."

Londonderry's population more than doubled between 1960 and 1970, from 2,457 to 5,346. **Derry** grew from 6,987 to 11,712, and reached 18,875 by 1980 (Bureau of the Census 1990). **Salem's** population in 1974 approached 19,000 (Turner and Noyes 1974:4). Between 1980 and 1990, **Derry's** population grew more than fifty percent from 18,875 to 29,603. **Londonderry's** population increased from 13,598 to 19,781, and **Windham's** from 5,664 to 9,000. **Manchester** grew from 90,936 people in 1980 to 99,567 in 1990 (Bureau of the Census 1990).

Automobile transportation made the railroad obsolete. As of 1950, passenger service through **Derry** and **Londonderry** was offered once a week on Sundays. The last passenger train passed through Salem, Windham, Derry and Londonderry in 1953. Freight transport continued on a limited scale, revived briefly by the energy crisis of the 1970s. As of the 1990s, the Manchester and Lawrence line was active for freight traffic between Salem and Lawrence, while northern sections were inactive (Monroe and Federer 1993). Trains ran from Boston to Rockingham Park in Salem until 1962 (Turner and Noyes 1974:86). The **Manchester** Airport has played an increasing role in the economy of the region. Grenier Field was returned to public use in 1957, and the Manchester Airport Authority was created in 1959 (Monroe 1991). The airport was expanded considerably in the late twentieth century.

In the late twentieth century, manufacturing declined and the workforce became dominated by service sector, technical and other non-manufacturing jobs. The shoe industry in West **Derry** only partially recovered after World War II, due to competition with southern mills that had access to cheaper labor and power. The end of the industry came in the 1980s with the closing of the last two factories. To some extent, the shoe industry was replaced with high-tech manufacturing companies, located primarily along Route 28 (Neil 1986). Older industries in **Salem**

were also closed. As of the 1970s, there were only two local factories, the Granite State Potato Chip Company and the Salem Coca Cola Bottling Company, both located on Route 28 (Turner and Noyes 1974:158, 150). Industrial development in the region focused on the **Manchester** Airport and industrial parks around it, particularly to the south in **Londonderry** where large tracts of undeveloped land were available. By the late twentieth century, only a small percentage of area residents worked in the same town in which they lived. In Derry, as of 1986, 73 percent of workers commuted to other towns and of these, 34 percent worked in Massachusetts (Monroe 1986).

Local farming essentially came to an end, though many properties retain agricultural land and buildings. In the late twentieth century, apples are the only surviving local crop in **Londonderry**. They are marketed throughout New England, and exported to Canada and South America, while apple picking is a popular tourist attraction in the fall (Schmidtchen 1977:11; Monroe and Federer 1995). There are currently five commercial orchards in Londonderry, with Woodmont Orchards being the largest at almost 200 acres under cultivation. Nassar's Orchard operates on the west edge of the study area in **Windham**. In **Salem**, poultry farming peaked in 1950, and by the 1960s all poultry farmers were out of business. Dairy farming also declined until there were only two dairy farms operating in town in 1974 (Turner and Noyes 1974:158). The Armenian market farm era came to an end in the mid-1950s, when the competition brought about by new developments in the transportation and storage of produce effectively made these small local farming operations an anachronism. Only one small market farm continues to operate in the area, the Peters farm stand at the southeast intersection of Kelley Road and Cross Street. Other Salem farms include South Policy Farm run by the Hagopian family, the Donabedian Farm on Lawrence Road and another on Kelley Road. In Windham, the Johnson family of Range Road operated a dairy farm until 1980 (Monroe and Federer 1992). The Johnson Farm, which continues as a market farm with roadside shop, is now one of the only operating farms in the project area.

Population growth resulted in a major building boom in the study area towns as throughout Southern New Hampshire. In rural areas, land that had once been pasture and field, and had reforested during the first half of the Twentieth century, became the location of tracts of houses. In Salem, the building boom created extensive residential subdivision and newer homes were erected among the older buildings in historic areas. An early subdivision was Noyes Terrace in South Salem (southeast of study area) built in 1948. Other mid-twentieth century subdivisions are "The Macs" built off Kelly Road in the early 1960s and the large area between Millville Road and Route 28 north of Salem Depot. Most of the lakefront cottages in the study area were converted to year-round use. In **Windham** a great deal of recent development has occurred on the west side of Canobie Lake and the shores of Cobbetts Pond. At the north end of the study area, substantial single-family and multi-family residential development has occurred along Bodwell Road, with the west side of the road being largely apartment complexes, while the east side has seen substantial individual new houses and several small subdivisions. Virtually all of

this construction dates from the 1970s and thereafter, though some ranch house construction from the 1950s appears along the north end of Bodwell Road and Cohas Avenue, at the northernmost end of the study area, closest to downtown Manchester.

New commercial and business development focused around interchanges along I-93. In **Salem,** Exit 1 leads to the vast Mall at Rockingham Park. Large scale commercial development has also taken place along Route 28 in Salem and on a less dense scale to the north in Windham. Commercial and office development in Londonderry is concentrated along Route 102 near Exit 4 on I-93, just west of the older village of West Derry. East of the study area, Route 28 (Crystal Avenue and Rockingham Road north of West Derry is heavily developed, the one of nearly every chain of restaurant and store. To the north, Route 28 on either side of Exit 5 on I-93 is also the location of commercial activity.

3.10.5.3 Individual Properties and Historic Districts Eligible for the National Register of Historic Places

A total of thirty-eight properties and five potential historic districts (containing twenty-two individual properties also surveyed individually) were surveyed as part of this undertaking.

The material developed for this study is available at NHDHR, NHDOT and FHWA, along with documentation and discussion of eligibility.

The following is a description of those properties that have been determined eligible for the National Register of Historic Places.

Salem

The Armenian Settlement Historic District (SAL-D1) is located in southwestern Salem, west of I-93 near Exit 1. The area encompasses approximately 105 acres along Salem Street between the intersection of Salem Street, Cross Street and Brady Avenue and the Massachusetts border. The Armenian Settlement Historic District is eligible for the National Register under Criterion A for its associations with the significant regional trend of Armenian immigrant settlement in America and its evolution over 100 years.

Armenians began immigrating to the United States after 1890, when the political persecution by the ruling Turkish government became untenable. This treatment worsened over time, with mass executions of Armenians occurring intermittently over the next two decades, culminating in the Armenian Genocide of 1915.

This rural neighborhood of south Salem is directly associated with the earliest influx of Armenian immigrants who purchased land and established farmsteads here in the

first years of the twentieth century for the purpose of market gardening. They later established other businesses here, particularly in heavy construction.

The Kinzler House (SAL0204) is eligible for the National Register of Historic Places under Criterion A for its historical associations with road agent Bill Kinzler and New Hampshire's Good Roads Movement as it unfolded in the Town of Salem throughout the 20th century. Kinzler, who was born in this house and lived here all his life, was responsible for the development and maintenance of Salem's modern road system. The state's road system had deteriorated from lack of use following construction of the railroad network. The Good Roads Movement was an effort to improve New Hampshire's local roads in order to facilitate increasing automobile traffic. Kinzler advocated modern petroleum-based paving materials, using them to pave most of the town's roads in the 1920s-30s.

The property's history is also an interesting illustration of the "professionalization" of town government in New Hampshire, moving from the efforts of individuals – at times in their homes – to a more formal municipal organization. The property is located on the south side of Cross Street, west of I-93 near Exit 1. The eligible boundary for the Kinzler House includes 5.8 acres along Cross Street and I-93.

Windham

The George F. Armstrong House (WND0085) is located on the north side of Range Road (86 Range Road) between the north and southbound lanes of I-93. The property was determined to be eligible for the National Register of Historic Places under Criterion C in 1992 as one of the best examples of a late 19th century vernacular wood-framed, gable-front dwelling in Windham. It is a significant farm complex including barn, barnyard, and connected sheds. The 1992 eligible boundary encompassed the house and its domestic setting, and extended to parcel 17G/30 to include the Armstrong barn and barnyard, resulting in an eligible parcel of 3.91 acres. Since then, the barn, barnyard, and connected sheds once associated with the house have been converted to a restaurant and extensively altered and expanded. The new boundary of the eligible property now includes only the footprint of the house and its character-defining domestic space (primarily its front and east side yard), but excluding the much-altered barn.

The Robert Armstrong House (WND0086) is located on the north side of Range Road (88 Range Road), between the north and southbound lanes of I-93. The property is eligible for the National Register under Criterion C as a very fine local example of an early Federal period 2 1/2 story, 5-bay, one room deep dwelling. It is further distinguished by the high quality, integrity and originality of its interior features and finishes. It also retains some historic landscape features, including two large trees which frame the roadside view and define its dooryard. Later 19th century additions to rear are in the nature of "connected architecture," a reflection of its history as a farmhouse. The eligible boundary for the Armstrong House is limited to the footprint of the dwelling and its domestic space.

Indian Rock (WND0206) is a large natural boulder with a circular depression on top traditionally held to be the site where Native American inhabitants of the Windham area pounded corn. The rock is located in the woods on the north side of Indian Rock Road in Windham, on the old road bed for what is now NH Route 111. The rock was first mentioned in L.A. Morrison's 1883 history of Windham. A preservation committee was formed by the town in 1932 and a bronze commemorative plaque was placed on the rock by the town in 1933. The impetus for commemorating the rock may have been the heavy construction going on along Indian Rock Road at the time. Windham turned Indian Rock Road over to state control in 1932 and several campaigns of road work straightened the route from its original, winding path.

Indian Rock is eligible for the National Register under Criteria Consideration F, representing the early 20th century Colonial Revival movement's interest in colonial history and desire to preserve relicts of that history. The erection of the plaque on the rock is symbolic of the value Windham residents put on the former Native American population of the area. The rock is mentioned as an important historic landmark in every townwide historical publication since 1883. The eligible boundary for Indian Rock is the immediate setting of the rock between it and Route 111, incorporating the pathway from the road and the wooded surroundings.

The George Dinsmore House (WND0033), located on the south side of Indian Rock Road (82 Indian Rock Road) on the shore of Cobbetts Pond, was determined eligible for the National Register in 1994 under Criterion C as a "distinctive and well-executed local example of the Craftsman Style executed in stone, reflecting the strong influence the construction of Searles Castle had on the architecture of the area." The eligible boundary is limited to a 1.1-acre parcel along Indian Rock Road, which encompasses the dwelling, stone outbuildings, and mature trees that reinforce the historic setting of the property.

The Searles Castle Historic District (WND-D1) was determined eligible for the National Register under Criterion C in 1994. The district is roughly bounded by Searles Road on the east, NH Route 111A on the south, and Indian Rock Road (NH Route 111) and I-93 on the west. The northern boundary runs between Searles Road and I-93 to encompass approximately 95 acres. The Searles Castle Historic District is significant as the best surviving example of the artistic collaboration between architect Henry Vaughan and his patron, Edward Searles. The pair sought to create an idealized environment, a "kingdom of architecture and landscape," which expressed the qualities of a spiritual and aesthetic retreat through use of the Gothic Revival style. The buildings and structures within the district express an archaeological correctness in the architect's use of Gothic elements, rustic stone construction, and the ecclesiastical qualities of the interiors. The surrounding grounds offer a sense of seclusion and picturesque qualities.

Londonderry

The Woodmont Orchards Historic District (LON-D1) is eligible for the National Register under Criterion A for its historic associations with the commercial apple growing industry and with the significant contributions of Rosencrans Pillsbury and William Lievens to the industry. In the 20th century, apple growing quickly outpaced all other agricultural pursuits in Londonderry and the region. Woodmont is the largest of five commercial orchards remaining in town today and continues to be owned and operated by the Lievens family. The eligible boundary for the orchard covers 196 acres on both sides of Pillsbury Road west of I-93.

Although not yet fifty years old, **The Robert J. Prowse Memorial Bridge (LON0116)** is eligible for the National Register of Historic Places under Criterion C through Criterion Exception G for its importance in the history of New Hampshire bridge engineering. The bridge carries Ash Street/Pillsbury Road over I-93 between Exits 3 and 4. Only four steel rigid frame bridges have been identified in New Hampshire: this one, designed as early as 1958 and built ca. 1962; Route 10 over the Ashuelot River in Gilsum, designed by the NH Highway Department in 1935; the Canal Street approach to the Notre Dame Bridge in Manchester, designed by J.R. Worcester and Co. of Boston in 1936 and demolished ca. 1988, and the East Side Road bridge over I-393 in Concord, built ca. 1978. The Gilsum bridge was determined to be eligible in 1999. The eligible boundaries for the Robert J. Prowse Bridge are limited to the bridge footprint.

The Reed Paige Clark Homestead (LON0114) is eligible for the National Register of Historic Places under Criteria A and C. It is significant under Criterion A for agriculture as a connected farm complex with fields defined by dry-laid granite walls. It is eligible under Criterion C as an extremely well-preserved example of connected farm architecture, executed in stone in the Greek Revival style. The homestead is located on the corner of Stonehenge and Perkins Roads west of I-93. The eligible boundary encompasses 114.4 acres, the majority of which is located south of Stonehenge Road, abutting the west side of I-93.

The Shepard House (LON0103), built ca. 1952 at 99 Rockingham Road, is individually eligible for the National Register of Historic Places under Criterion C as a well-defined example of the Ranch style and form. The eligible boundary covers the entire 9-acre lot. A ca. 1970 rear addition does not appear to overwhelm the house's original design intent. The Shepard House is one of a number of ranch houses built in a post-war subdivision called Meadow Estates laid out on both sides of Rockingham Road in 1947.

The Moody House (LON0117), built ca. 1952 at 113 Rockingham Road, is individually eligible for the National Register of Historic Places under Criterion C as a well-defined and extremely well preserved example of the Ranch style and form. Even its period landscaping and setting are intact. The eligible boundary covers the entire 1.4-acre lot. The Moody House is one of a number of ranch houses built in a

post-war subdivision called Meadow Estates laid out on both sides of Rockingham Road in 1947.

The Gearty House (LON0105), located on the west side of Rockingham Road (117 Rockingham Road), is less than fifty years old but is of such exceptional significance that it is eligible for the National Register under Criterion C and Criterion Exception G as a well-defined example of ranch style form. The eligible boundary covers the entire 1.5-acre Gearty House lot. The Gearty House is one of a number of ranch houses built in a post-war subdivision called Meadow Estates laid out on both sides of Rockingham Road in 1947.

Manchester

The Charles R. Clark House (MAN0010), located at 2081 Bodwell Road, is eligible for the National Register under Criterion C as a rare representation of stone masonry construction in Manchester. It is one of only two known stone houses in Manchester. The rough stone work is well executed. The house has a distinctive intersecting hall plan. The property is located on the northwest side of Bodwell Road, just over the Manchester border. The eligible boundaries for the property cover approximately 17-acres of land between Bodwell Road and Cohas Brook.

The Manchester Low Service Waterworks Historic District (MAN-D1) is eligible for the National Register under Criteria A and C.

The Manchester Low-Service Pumping Station, an excellent example of High Victorian Gothic architecture, was designed in 1872 by the nationally prominent engineer John Thomas Fanning (1837-1911). J. T. Fanning was a nationally recognized engineer, architect, and author, whose career warrants recognition.

The Manchester Waterworks also gains significance as the first mechanically powered municipal water supply system in New Hampshire. Although today termed a “low service” system, the Manchester Waterworks would have provided “high service” by nineteenth-century standards, utilizing hydromechanically-powered pumps to raise water from the 250-foot elevation of Lake Massabesic to a 16-million-gallon reservoir elevated at 350 feet, about 150 feet above the elevation of Elm Street. The reservoir on Mammoth Road is part of the original water supply system, being connected to the pumping station by a 7000-foot force main through which 2.8 to 5.7 million gallons were pumped each twenty-four hours.

The Manchester Low Service Waterworks Historic District is a linear district, reaching from Lake Massabesic on the eastern end, through the canal system to the pumping station on Bodwell Road, and along the force main to the Manchester City Reservoir on Mammoth Road to the west. The district encompasses approximately fifty-five acres.

Additional Research Based on Finding of the Archaeological Investigations

The supplemental archaeological field investigations conducted between the DEIS and FEIS located one potentially significant feature within the Selected Alternative that may require additional historic and architectural investigation. This property includes high rubble stone walls associated with the Searle Estate (27 Rk 366) (see Table 3.10-1 and **Figure 3.10-1**). This study would entail an addition to NHDHR District Area Form.

3.11 Socio-Economic Resources

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3.11.1 Demographics

The five study area communities fall within two different counties and three different labor market/metropolitan statistical areas. Derry, Londonderry, Salem, and Windham are located in Rockingham County, and Manchester is located in Hillsborough County. Derry, Salem, and Windham are part of the NH portion of the Lawrence, MA Primary Metropolitan Statistical Area (PMSA)[34]; Londonderry is part of the Nashua Primary Metropolitan Statistical Area (PMSA)[35]; Manchester is part of the Manchester Primary Metropolitan Statistical Area (PMSA)[36]. Manchester, Derry and Londonderry are part of the Southern New Hampshire Regional Planning Commission, and Windham and Salem are part of Rockingham Regional Planning Commission. Population, housing, employment, and wage information for these areas is presented and analyzed below.

3.11.1.1 Population

Derry, Londonderry, and Windham each experienced substantial population growth over the 1970's and 1980's. Average annual growth in these three communities during these periods ranged from 6 to 15 percent. The populations of Londonderry and Windham roughly tripled between 1970 and 1990, with Londonderry growing from approximately 5,300 to 19,800 people and Windham increasing from 3,000 to 9,000 people. Derry's population more than doubled over the same period, increasing from approximately 11,700 to 29,600. Between 1990 and 2000 growth slowed for all five communities, with an average annual growth rate slightly under 2 percent (see Table 3.11-1 Population).

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[34] The other communities in the NH portion of the Lawrence, MA PMSA are Atkinson, Brentwood, Danville, East Kingston, Hampstead, Kingston, Newton, Plaistow, Sandown and Seabrook.

[35] The other communities in the Nashua PMSA are Amherst, Brookline, Hollis, Hudson, Litchfield, Merrimack, Milford, Mont Vernon, Nashua and Wilton.

[36] The other communities in the Manchester MSA are Allenstown, Auburn, Bedford, Candia, Goffstown and Hooksett.

Table 3.11-1
Population

Comments	1970	1980	1990	2000	Absolute Change 1970-1980	Average Annual Change 1970—1980	Absolute Change 1980-1990	Average Annual Change 1980-1990	Absolute Change 1990-2000	Average Annual Change 1990-2000
Salem	20,142	24,124	25,746	28,112	3,982	1.98%	1,622	0.67%	2,366	0.92%
Windham	3,008	5,664	9,000	10,720	2,656	8.83%	3,336	5.89%	1,720	1.91%
Derry	11,712	18,875	29,603	34,021	7,163	6.12%	10,728	5.68%	4,418	1.49%
Londonderry	5,346	13,598	19,781	23,263	8,252	15.44%	6,183	4.55%	3,455	1.75%
Manchester	87,754	90,936	99,332	107,006	3,182	0.36%	8,396	0.92%	7,343	0.74%
Rockingham County	138,950	190,345	245,845	277,359	51,395	3.70%	55,500	2.92%	31,514	1.28%
Hillsborough County	223,941	276,608	335,838	380,841	52,667	2.35%	59,230	2.14%	45,003	1.34%
New Hampshire	737,578	920,475	1,109,117	1,235,876	182,897	2.48%	188,642	2.05%	126,669	1.14%

Source: 1970 U.S. Census
1980 U.S. Census
2000 U.S. Census

Average annual population increases during the 1970's and 1980's in these three communities were substantially higher than for Rockingham County (nearly 3 percent) or the state as a whole (2 percent). Derry and Londonderry also experienced the greatest absolute growth of the five study area communities, increasing by 17,900 and 14,400 people respectively between 1970 and 1990. Between 1990 and 2000, growth was slower, with absolute growth of approximately 4,400 and 3,500 respectively.

In Salem, population growth was more moderate during the 1970's (nearly 2 percent average annual change) and 1980's (less than 1 percent), falling below average annual growth rate for Rockingham County in both decades. The 1990's have seen Salem's growth rate rebound to nearly 1 percent, in keeping with the rate for Rockingham County's as a whole. Manchester also experienced relatively slow growth during this period, with average annual percent growth of approximately ½ percent during the 1970's and less than 1 percent during the 1980's. This was substantially below average annual growth rates in Hillsborough County (2.4 percent during the 1970's and 2.1 percent during the 1980's) and the state as a whole (2.5 percent during the 1970's and 2.0 percent during the 1980's). Manchester's average annual growth rate has remained low during the 1990's, at less than 1 percent, though it is in less variance with Hillsborough County (at 1 percent) and the state as a whole (less than 1 percent than in earlier decades) (see Table 3.11-1 Population). Absolute growth of 7,343 for Manchester in the 1990's, however, is the largest for this time period, matching the absolute growth of Derry and Londonderry in the 1970's.

3.11.1.2 Housing

Table 3.11-2 depicts the Year 2000 number of housing units in each of the five study area communities, as well as Rockingham County, Hillsborough County, and the state as a whole. Manchester has the most housing units with 45,892 units, followed by Derry with 12,735 units, Salem with 10,866 units, Londonderry with 7,718 units and Windham with 3,906 units.

The most substantial average annual growth in housing units over the 1980-1990 decade was experienced by Windham, (9 percent), Derry (6 percent), and Londonderry (5 percent). Generally these figures were higher than average annual percent growth in the County (3 percent) or the state (3 percent) over the same period. From 1990-2000, however, these average annual growth rates dropped, to an average rate of about 1 percent.

Table 3.11-3 depicts housing units by type for each of the study area communities. While each of the five communities offers a range of housing types, the 1996 housing mix in Manchester and Derry is characterized by relatively large percentages of multi-family units, 63 percent and 46 percent respectively. At the other end of the spectrum, Windham is comprised predominantly of single family homes (91 percent) (see Table 3.11-2. Total Housing Units and Table 3.11-3. Housing Units by Type.)

Table 3.11-2
Total Housing Units

	All Housing Units			Average Annual Change	
Comments	**1980**	**1990**	**2000**	**1980-1990**	**1990-2000**
Salem	8,848	9,897	10,866	1.2%	0.9%
Windham	1,726	3,327	3,906	9.3%	1.7%
Derry	7,280	11,869	12,735	6.3%	0.7%
Londonderry	4,584	6,739	7,718	4.7%	1.5%
Manchester	35,869	44,361	45,892	2.4%	0.4%
Rockingham County	76,115	100,479	113,023	3.2%	1.3%
Hillsborough County	101,208	135,622	149,961	3.4%	1.1%
New Hampshire	386,381	502,247	547,024	3.0%	0.9%

Source: 1980 U.S. Census
2000 U.S. Census
1990 U.S. Census and 1996 estimates as published in Current Estimates and Trends in New Hampshire's Housing Supply, Update: 1996, NH Office of State Planning, 1997, and Corrections to Current Estimates and Trends in New Hampshire's Housing Supply, Update: 1996, NH Office of State Planning, 1998

Table 3.11-3
Housing Units-By Type

	All Housing Total		Single Family			Multi-Family			Mobile Homes		
Community	1990 Number	1996 Number	1990 Number	1996 Number	1996 %	1990 Number	1996 Number	1996 %	1990 Number	1996 Number	1996 %
Salem	9,897	10,672	6,710	7,300	68%	2,321	2,506	23%	866	866	8%
Windham	3,327	3,708	3,031	3,384	91%	284	312	8%	12	12	-
Derry	11,869	12,737	5,549	6,355	50%	5,747	5,807	46%	573	575	5%
Londonderry	6,739	7,411	4,395	4,991	67%	1,754	1,828	25%	590	592	8%
Manchester	44,361	45,316	15,306	16,318	36%	28,569	28,507	63%	486	491	1%
Rockingham County	100,479	109,110	61,121	68,406	63%	30,508	31,556	29%	8,850	9,148	8%
Hillsborough County	135,622	144,131	71,819	79,198	55%	59,104	60,011	42%	4,699	4,922	3%
New Hampshire	503,541	534,111	297,448	322,567	60%	162,998	166,523	31%	41,801	45,021	8%

Source: 1990 U.S. Census and NH Office of State Planning estimates as published in "Current Estimates and Trends in New Hampshire's Housing Supply, Update: 1996", NH Office of State Planning, December 1997; Corrected February 1998

3.11.1.3 Employment

The City of Manchester is a major regional employment center, providing approximately 55,850 jobs to area residents as of 1990. Salem also has a substantial economic base, with 15,400 jobs. Derry and Londonderry, with smaller employment bases, provided approximately 6,400 jobs and 5,600 jobs in 1990. Windham has the smallest employment base of the five study area communities, with 1,300 jobs (see Table 3.11-4. 1990 Average Annual Employment.)

Table 3.11-4
1990 Average Annual Employment

	Salem		Windham		Derry		Londonderry		Manchester	
Sector	Number	%	Number	%	Number	%	Number	%	Number	%
Manufacturing	4,025	26%	174	13%	1,456	23%	1,035	19%	9,510	17%
Construction and Mining	395	3%	234	18%	360	6%	509	9%	1,476	3%
Trans., Comm. and Utilities	473	3%	31	2%	191	3%	481	9%	2,878	5%
Trade	5,849	38%	420	32%	1,550	24%	1,740	31%	14,769	26%
Finance, Insurance and Real Estate	457	3%	74	6%	250	4%	191	3%	6,000	11%
Government	645	4%	--		644	10%	--		3,672	7%
Service and Other	3,556	23%	388	29%	1,926	30%	1,604	29%	17,545	31%
Totals	15,400		1,321		6,377		5,560		55,850	

Source: 1990 Profile, Employment and Wage Data, NH Employment Security, Economic and Labor Market Information Bureau, 1992
1990 County Profile, Employment and Wage Data, NH Employment Security, Economic and Labor Market Information Bureau, 1992

The principal economic sectors within Rockingham County and Hillsborough County include trade, services, and manufacturing. In 1990, trade accounted for 32 percent of employment in Rockingham County, while services accounted for 25 percent, and manufacturing for 17 percent. By 1996, trade grew to 34 percent and services to 29 percent, while manufacturing dropped to 15 percent of the total from 1990 in Rockingham County. In Hillsborough County manufacturing employment played a larger role than in Rockingham County, with 27 percent of employment, followed by services and trade, each with 25 percent. By 1996, however, dominance had reversed in Hillsborough County with service jobs representing 29 percent, trade at 24 percent and manufacturing at 23 percent. (see Table 3.11-5. 1990 and 1996 Average Annual Employment.)

Table 3.11-5
1990 Average Annual Employment

	Rockingham County		Hillsborough County		Manchester PMSA		NH Portion Lawrence-Haverhill PMSA		Nashua PMSA	
Sector	Number	%	Number	%	Number	%	Number	%	Number	%
Manufacturing	15,430	17%	43,543	27%	11,104	15%	7,347	21%	30,930	37%
Construction and Mining	5,094	6%	6,036	4%	3,338	5%	1,986	6%	2,968	4%
Trans., Comm. And Utilities	4,143	5%	6,729	4%	3,566	5%	1,868	5%	2,233	3%
Trade	29,584	32%	40,344	25%	20,237	28%	12,369	35%	20,768	25%
Finance, Insurance and Real Estate	5,820	6%	11,372	7%	8,040	11%	1,134	3%	3,235	4%
Government	8,343	9%	11,296	7%	5,089	7%	2,986	8%	5,941	7%
Service and Other	22,949	25%	40,682	25%	21,803	30%	7,772	22%	18,523	22%
Totals	91,363		160,002		73,177		35,462		84,598	

Source: 1990 Profile, Employment and Wage Data, NH Employment Security, Economic and Labor Market Information Bureau, 1992
1990 County Profile, Employment and Wage Data, NH Employment Security, Economic and Labor Market Information Bureau, 1992

1996 Average Annual Employment

	Rockingham County		Hillsborough County		Manchester PMSA		NH Portion Lawrence-Haverhill PMSA		Nashua PMSA	
Sector	Number	%	Number	%	Number	%	Number	%	Number	%
Manufacturing	16,260	15%	40,304	23%	13,203	14%	6,324	16%	26,988	31%
Construction and Mining	1,209	1%	5,764	3%	4,000	4%	2,038	5%	2,795	3%
Trans., Comm. and Utilities	5,576	5%	6,213	4%	5,368	6%	1,131	3%	2,159	3%
Trade	36,289	34%	42,294	24%	22,749	25%	15,214	37%	21,892	25%
Finance, Insurance and Real Estate	4,843	5%	10,789	6%	7,709	8%	1,006	2%	3,300	4%
Government	11,406	11%	17,265	10%	9,950	11%	3,806	9%	7,470	9%
Service and Other	30,713	29%	51,163	29%	29,091	32%	11,087	27%	21,581	25%
Totals	106,266		173,792		92,070		40,604		86,185	

Source: 1996 Profile, Employment and Wage Data, NH Employment Security, Economic and Labor Market Information Bureau, 1998

Similarly, manufacturing, services, and trade are the most important economic sectors within the Manchester PMSA, Nashua PMSA, and NH portion of the Lawrence, MA PMSA. Services are the primary industry in the Manchester PMSA with 32 percent of 1996 employment, up from 30 percent in 1990. In the NH portion of the Lawrence-Haverhill, MA PMSA, trade is the principal industry, with 37 percent of employment in 1996, up from 35 percent in 1990. In the Nashua PMSA, manufacturing is the predominant industry, with 31 percent of employment in 1996, down from 37 percent in 1990 (see Table 3.11-5. 1990 and 1996 Average Annual Employment).

In 1990, the trade, services, and manufacturing sectors constitute the primary economic sectors within the five individual I-93 study area communities, with the exception of Windham, where construction and mining plays a stronger economic role (18 percent) than manufacturing (13 percent). In Derry and Manchester, services

and trade are the most important employment sectors. The services and trade sectors account for 30 percent and 24 percent respectively of employment in Derry, and 31 percent and 26 percent, respectively, of employment in Manchester. In Londonderry and Windham, trade and services played the strongest economic roles. Trade accounted for 31 percent of employment in Londonderry and 32 percent of employment in Windham, while services comprised 29 percent of employment in both Londonderry and Windham. In Salem, trade was the strongest sector, with 38 percent of employment, followed by manufacturing with 26 percent (see Table 3.11-4. 1990 Average Annual Employment).

While Manchester had experienced an economic downturn in the late 1980's, similar to New England as a whole, during the mid-1980s, Manchester was ranked first nationally in terms of business climate by U.S. News and World Report. During this same period, Inc. Magazine ranked the Manchester-Nashua area eighth out of fifty of the nation's fastest growing cities based on a four-year pattern of job generation, business start-ups, and number of rapidly growing firms. In fact, between 1990 and 1996, the Manchester PMSA generated approximately 18,900 jobs, an average annual growth rate of 4.3 percent.

In Londonderry, substantial increases in the number of job opportunities occurred during the 1970s and 1980s due to industrial growth in the Manchester Airport area, commercial development along NH 102 and NH 28, and increases in local government employment necessitated by dramatic population growth. The majority of additional manufacturing sector job growth in Londonderry is expected to occur in the existing industrially zoned areas near the Manchester Airport in the northwest corner of town. New commercial job growth is expected to occur in proximity to NH 102, NH 28 near Exit 5, and between the Derry town line and the east side of I-93 south of NH 28. Development in these areas continues to be supported by Londonderry's 1997 Master Plan.

Salem's economic base experienced substantial expansion during the late 1980s. Between 1986 and 1989, Salem approved 24 retail projects, 31 industrial projects, 15 office projects, and the Rockingham Mall which was expected to account for 150 stores and 4 major anchors, and generate approximately 2,000 jobs. While currently developing at a slower pace, approved projects in 1997 and 1998 have included 7 retail projects, 4 industrial projects, 5 office buildings, 2 restaurants and 2 day care operations.

Windham is primarily a bedroom community, illustrated by the subdivision approval of 230 house lots in 1997 and 1998. It has the smallest employment of the five study area communities, with a 1990 average annual employment of 1,320. Employment opportunities in Windham are primarily limited to businesses located along NH 28 and NH 111, in West Windham and Windham Depot, in the town's industrial park off NH 111 near the Salem town line, and at numerous home occupations scattered throughout town.

In Derry, the shoe industry was, for many years, the mainstay of the Town's manufacturing sector. In 1965, this industry accounted for more than 80 percent of Derry's manufacturing employment. Derry has increasingly become a residential suburban community with almost three-quarters of its residents commuting out-of-town to work by 1980. Despite this shift, Derry continues to provide a substantial number of employment opportunities. In 1990, Derry provided approximately 1,450 manufacturing jobs, 1,550 trade sector jobs, and 1,930 services sector jobs.

3.11.1.4 Wages

Table 3.11-6 presents 1990 and 1996 average weekly wages by manufacturing and non-manufacturing sectors for each community within the study area as well as counties. Table 3.11-7 presents the 1993 and 1996 average weekly wages by employment category for labor market statistical areas within which the study area communities lie.

In 1990, Salem had the highest average weekly wages for all employment ($475) of the study area communities, while Derry ($374) had the lowest. By 1996, Manchester had edged above Salem ($562 vs. $527), and Derry remained with the lowest ($489).

1990 and 1996 industry-wide average weekly wages for Derry ($374 and $489) and Windham ($399 and $494) were below that of Rockingham County ($429 and $529) in which they are located. Salem's 1990 and 1996 average weekly wages ($475 and $527 compare to $429 and $529 for the County averages. 1990 and 1996 industry-wide average weekly wages in Londonderry ($443 and $543) were above Rockingham County average wages ($429 and $529). 1990 and 1996 average weekly wages in Manchester ($456 and $562) were below Hillsborough County ($481 and $591) (**Table 3.11-6**).

Average annual wage growth continued in all labor market areas between 1993 and 1996. The range in relative wages for the various employment categories, however, is substantial and also continues. For example, within the Manchester MSA, average annual weekly wages for retail trade were $272.46 in 1993 and $313.03 in 1996, while finance, insurance and real estate's (FIRE) average annual wages were $624.36 and $700.31 for the same time periods. This illustrates a difference of 129 percent between retail and FIRE employment categories in 1990 and 124 percent in 1996.

In summary, manufacturing wages are high in Salem with its manufacturing being related to the Boston metropolitan area. Non-manufacturing wages, on the other hand, are higher in Manchester with its independent economic base.

Table 3.11-6
1990 Average Weekly Wages
Private Employment

Sector	Salem	Windham	Derry	Londonderry	Manchester	Rockingham County	Hillsborough County	New Hampshire.
Manufacturing	732.02	461.96	477.78	564.06	546.64	622.56	650.27	569.01
Non-Manufacturing	378.22	389.37	338.90	415.69	423.84	-	-	-
Tot Priv't Empl	474.74	398.93	374.18	443.31	445.90	428.77	481.04	432.37

Source: New Hampshire Employment and Wages by Cities and Towns 1990, NH Employment Security, Economic and Labor Market Information Bureau, 1992

1996 Average Weekly Wages
Private Employment

Sector	Salem	Windham	Derry	Londonderry	Manchester	Rockingham County	Hillsborough County	New Hampshire.
Manufacturing	854.24	646.72	609.50	784.43	651.76	763.56	800.35	699.88
Non-Manufacturing	460.86	478.46	448.90	490.72	542.40	-	-	-
Tot Priv't Empl	526.62	494.18	489.20	542.81	562.08	528.95	590.55	531.68

Source: 1996 County Profile, Employment and Wage Data, NH Employment Security, Economic and Labor Market Information Bureau, 1998

1990-1996 Annual Average Change in Average Weekly Wages
Private Employment

Sector	Salem	Windham	Derry	Londonderry	Manchester	Rockingham County	Hillsborough County	New Hampshire.
Manufacturing	2.8%	6.7%	4.6%	6.5%	3.2%	3.8%	3.9%	3.8%
Non-Manufacturing	3.6%	3.8%	5.4%	3.0%	4.7%	-	-	-
Tot Priv't Empl	1.8%	4.0%	5.1%	3.7%	4.3%	3.9%	3.8%	3.8%

Table 3.11-7
Average Weekly Wages

Sector	1993 New Hampshire	1993 Manchester MSA	1993 Nashua PMSA	1993 NH Portion Lawrence PMSA	1996 New Hampshire	1996 Manchester MSA	1996 Nashua PMSA	1996 NH Portion Lawrence PMSA
Manufacturing	627.06	589.09	793.18	661.08	699.88	675.65	869.38	740.70
Construction	508.94	534.07	521.74	485.24	577.86	626.12	637.62	596.51
Trans., Comm. and Util.	605.71	675.41	487.45	415.40	660.66	754.31	548.23	499.15
Trade Retail	272.77	272.46	289.12	251.07	298.87	313.03	312.26	278.31
Fin, Insur and Real Est	586.90	624.36	578.50	489.31	676.95	700.31	658.49	599.56
Government	506.77	593.45	600.09	474.18	538.15	626.95	617.76	538.89
Service	446.73	487.26	471.14	478.25	498.53	538.12	544.79	520.68
All Employment	480.11	509.00	570.55	434.60	532.53	**567.46**	**623.37**	**500.71**

Source: 1993 Profile, Employment and Wage Data, NH Employment Security, Economic and Labor Market Information Bureau, 1998
1996 Profile, Employment and Wage Data, NH Employment Security, Economic and Labor Market Information Bureau, 1998

1993-1996 Average Annual Change In Average Weekly Wages

Sector	New Hampshire	Manchester MSA	Nashua PMSA	NH Portion Lawrence PMSA
Manufacturing	3.9%	4.9%	3.2%	4.0%
Construction	4.5%	5.8%	7.4%	7.6%
Trans., Comm. and Util	3.0%	3.9%	4.2%	6.7%
Trade, Retail	3.2%	5.0%	2.7%	3.6%
Fin, Insur and Real Est	5.1%	4.1%	4.6%	7.5%
Government	2.1%	1.9%	1.0%	4.6%
Service	3.9%	3.5%	5.2%	3.0%
All Employment	3.6%	3.8%	3.1%	5.1%

3.11.1.5 Unemployment Rates

Unemployment rates for 1991, by county and statistical area, as well as for the state as a whole, are presented in Table 3.11-8. Unemployment rates in Rockingham County (8.0 percent) and Hillsborough County (7.5 percent) were slightly higher than for the state as a whole (7.2 percent). While the unemployment rate for the Manchester PMSA (7.3 percent) was slightly higher than for the state (7.2 percent), the unemployment rate for the NH portion of the Lawrence, MA PMSA (9.8 percent) was higher still than for the state. The unemployment rate in the Nashua PMSA was slightly higher than for the state as a whole, at 7.4 percent.

Table 3.11-8 also depicts unemployment rates for each community in the I-93 study area. Derry and Salem, at 9.9 percent and 9.8 percent respectively, had the highest unemployment rates of the five I-93 study area communities. Manchester and Windham had the next highest unemployment rates at 8.0 percent, both above the 7.2 percent statewide average. Londonderry (6.9 percent) was the only study area community that had an unemployment rate lower than for that for the state as a whole.

The January – August 1998 unemployment rates were substantially lower. Unemployment in the five towns ranged from 4.9 percent in Salem and 4.6 percent in Windham to 2.4 percent in Londonderry and 2.6 percent in Manchester. Unemployment in New Hampshire as a whole was 2.8 percent for the same period (see Table 3.11-8).

Table 3.11-8
Average Unemployment Wages

	1991 Average				Jan – Aug 1998 Average			
Community / Area	Labor Force	Employment	Unemployment	Unemployment Rate	Labor Force	Employment	Unemployment	Unemployment Rate
Salem	14,240	12,850	1,390	9.8%	16,731	15,918	814	4.9%
Windham	4,000	3,680	320	8.0%	5,738	5,475	263	4.6%
Derry	13,970	12,590	1,380	9.9%	19,154	18,474	668	3.5%
Londonderry	10,120	9,420	700	6.9%	12,449	12,148	301	2.4%
Manchester	58,620	53,930	4,690	8.0%	55,793	54,358	1,435	2.6%
NH Portion Lawrence PMSA	54,210	48,910	5,300	9.8%	73,814	70,779	3,035	4.1%
Nashua PMSA	99,160	91,780	7,380	7.4%	104,504	101,869	2,635	2.5%
Manchester PMSA	87,190	80,820	6,370	7.3%	101,690	99,201	2,489	2.5%
Rockingham County	132,160	121,650	10,510	8.0%	151,058	146,003	5,055	3.4%
Hillsborough County	187,580	173,430	14,150	7.5%	202,316	197,240	5,076	2.5%
New Hampshire	635,000	589,000	46,000	7.2%	653,998	635,698	18,300	2.8%

Source: 1991 and 1998 Local Area Unemployment Statistics Report, NH Employment Security, Economic and Labor Market Information Bureau, 3/25/92 and 9/24/98

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3.11.2 Existing Land Use

Existing land use patterns in the vicinity of I-93 are depicted on **Figure 3.11-1**. Locally referenced roads outside the project area are shown on **Figure 1.3-1**. A summary of the land uses for each study area community follows:

3.11.2.1 Salem

Salem has experienced rapid residential and commercial growth in the areas adjacent to Exits 1 and 2 over the past twenty years. While Salem Depot used to be the focal point of development, the areas bounded by I-93 to the west and the Spicket River to the east have now become highly developed. Much of the growth has been residential, making Salem a residential community for employment centers along the I-495 corridor in Massachusetts, such as Lawrence, Lowell, and the greater Boston area.

The major commercial area in Salem is centered along the NH 28 corridor that runs parallel to I-93 on the east through much of Salem. With the opening of the Rockingham Mall in 1991 and the re-opening of Rockingham Park in 1990, the area near the I-93 Exit 1 Interchange and the intersection of Rockingham Park Boulevard with South Broadway (NH 28) has developed as a major commercial center in Salem. A secondary commercial center has also developed along Main Street (NH 97), which intersects NH 28 east of Exit 2.

Industrial development has occurred adjacent to the Interstate in several places. West of Exit 2 industrial uses are found along Keewaydin Drive, Manor Parkway, Northwestern Boulevard and Industrial Parkway. East of the interchange is another industrial facility off Northeastern Boulevard. Much of this area is occupied by the Digital Equipment Corporation facility. Industrial activity is also found along Lowell Road and Garabedian Drive near the Massachusetts border.

The majority of the developed land adjacent to the Interstate is single-family residential. The more densely developed areas tend to be in three locations -- two east of the Interstate and one west. Near Exit 1 there is an area bounded by the Interstate, Rockingham Park Boulevard and South Broadway (NH 28). Most of the development occurs off Kelly and Hagop Roads, as well as Haigh Avenue. Several of these areas are quite close to the Interstate. Across the Interstate to the west is another major residential area that includes the Salem Street area and a substantial development in the area of Cross Street. The Cross Street residential area is also very close to the Interstate. Further north on the east side of the Interstate is a residential area that closely follows South Policy Street. After crossing Main Street, the residential area expands to cover much of the area between North Policy Street and

North Broadway (NH 28). A final residential area is found near the Windham town line on either side of the Interstate along Brookdale Road and South Shore Road, adjacent to Canobie Lake.

3.11.2.2 Windham

Windham is a suburban town that serves as a residential community for employment centers in Nashua, Manchester, Lawrence, Lowell, Haverhill, and the greater Boston area. Most of Windham's commercial businesses are located along NH 28 and NH 111. Business centers serving neighborhoods are scattered throughout the town. Windham's industrial uses are concentrated in the town's industrial park, located on Industrial Drive off NH 111 approximately 3/4 mile east of I-93 Exit 3.

The majority of developed land in Windham in close proximity to I-93 consists of residential land uses. The densest single family residential development is found around Cobbetts Pond, south of NH 111 and west of I-93; and between I-93 and Canobie Lake, to the east of I-93. The Cobbetts Pond/NH 111 neighborhood consists of a dense mix of seasonal homes, and cottages converted to year-round use. The residential neighborhood on the northwest shore of Canobie Lake comprises single family homes on 1/2- to 1-acre lots. Most of these homes were built after 1950. A relatively dense multi-family/condominium residential development is located just south of Exit 3 on Locust Road, adjacent to the west side of I-93 south of NH 111A (Range Road) and east of Cobbetts Pond.

The Jennys Hill area, off Searles Road east of I-93 where Searles Castle is located, is characterized by large lot single-family year-round homes built primarily during the 1980s. Clusters of residential development are also located in Windham Depot, just south of the Derry town line and east of I-93; along Morrison Road south and east of Windham Depot; and along North Lowell Road and County Road on the west side of I-93 south of Windham Depot. A few residences are also located in the median area along NH 111A (Range Road).

Commercial land uses within and adjacent to the study area are concentrated at Exit 3; between the northbound and southbound lanes of I-93, west and east of I-93 along NH 111 and NH 111A and along NH 111A (Range Road) in the I-93 median area. Industrial land use in the Windham portion of the study area is limited primarily to the Town's industrial park at Wall Street off NH 111, west of Exit 3.

3.11.2.3 Derry

Derry's town center, the most densely developed area, is located approximately 1 mile east of I-93 Exit 4, surrounding the intersection of NH 102 (Broadway) and NH 28. Derry is a suburban residential community characterized by a mix of single family, multi-family, and mobile home development. The Town's commercial uses

are concentrated primarily in Derry's central business district, located just east of Exit 4 along NH 102.

Developed land in proximity to the Derry portion of the I-93 study area consists primarily of residential uses. Residential uses, which are in closest proximity to I-93, include the "Derryfield Road neighborhood" (located in the triangle formed by Kendall Pond Road, Fordway Extension, and the east side of I-93), Tracy Drive, and a cul-de-sac off of Beacon Hill Road on the west side of I-93.

Other important land uses in proximity to the Derry portion of I-93 include the town's sewage treatment lagoons located on the Derry-Londonderry town line, immediately to the east of I-93; and a number of agricultural uses and open fields located to the east and west of I-93, north of the Derry-Windham town line.

3.11.2.4 Londonderry

Londonderry is characterized primarily by single family residential and agricultural land uses, with concentrated areas of commercial and industrial enterprises as well as some multi-family development. The largest residential developments in Londonderry are located along the town's north-south axis roads including Parmenter and Boyd Roads (from NH 102 south to the Hudson town line), High Range Road (from NH 102 north to Alexander Road), Mammoth Road (from NH 102 south to Beaver Brook), and Hardy and Gilcreast Roads (from Bancroft Road south to Beaver Brook).

Londonderry's largest concentration of commercial uses is located along NH 102 between Mammoth Road and the Derry town line in the vicinity of I-93 Exit 4. The town's industrial uses are concentrated in the vicinity of I-93 Exit 5 and in Londonderry's northwest corner in the Manchester Airport area. A large area of industrially zoned land (that is currently undeveloped) is located between I-93 and the Londonderry/Derry town line, located northeast of Exit 4 on I-93. Should a local project to construct a new interchange (known as Exit 4A) be successful, this industrially zoned area would be an important industrial area as well.

In addition to residential, commercial, and industrial development, agriculture is an important land use in Londonderry. While land used for agricultural purposes is spread throughout town, the largest concentrations of active agricultural land are located west of I-93 between Pillsbury Road and NH 102. A large tract of agricultural land is located adjacent to the west side of I-93 just north of Exit 4. This tract, the Woodmont Orchards, is roughly 400 acres in size.

3.11.2.5 Manchester

Manchester serves as an employment, shopping, and service center for surrounding communities. The City is generally characterized by high-density commercial, industrial, and residential urban development in the City's central core area,

surrounded on the fringes by suburban residential development. Land uses range from single family homes and neighborhood businesses to high rise multi-family housing, regional malls, and industrial facilities. The areas east of I-93 and south of I-293, as well as Manchester's northwest corner, are the City's least developed sectors. Much of the area east of I-93 is part of the Massabesic Lake watershed, which serves as a water supply for Manchester and surrounding communities. A large percentage of this watershed land is owned by the Manchester Water Works.

Developed land in proximity to the I-93 study area consists of single family and townhouse condominium development. The largest concentrations of residential development, which lie in closest proximity to I-93, are located between Bodwell Road and the east side of the Interstate. This development includes Tall Pines, Woodedge Estates, Newton Meadow, The Briars, Cohas Station and Sundance Gardens apartments and/or townhouse condominiums. East of the Interstate between Bodwell Road and the City line, a number of residential developments have recently been constructed or approved. Existing residential developments in this area include East Meadow townhouse condominiums; Foxwood Village (single-family homes) on Pheasant Lane; as well as single family housing on Megan Drive, Wildflower Drive and Morning Glory Drive.

On the west side of I-93, the densest residential development is located between Bryant Road and the Interstate. Most of the land west of I-93 and south of Crystal Lake and Corning Road is currently undeveloped.

With the exception of a farm in the southwest quadrant of the I-93/I-293 Interchange, there are no known farms or agricultural uses within the vicinity of the Manchester portion of the I-93 study area.

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3.11.3 Zoning

Zoning controls the potential use of land by limiting use to those which are allowed, or are conditionally allowed, and by promulgating development standards which, in turn, affect the cost and economics of development. Land within the I-93 study area is zoned for a variety of residential, commercial, and industrial uses with varying lot size, frontage, and other requirements. Zoning districts adjacent to I-93 within each town are described briefly below and depicted on **Figure 3.11-2**, Generalized Existing Zoning.

3.11.3.1 Salem

The Town of Salem is divided into thirteen (13) zoning districts:

- Rural
- Residential
- Garden Apartments
- Commercial-Industrial C
- Highway-Commercial
- Industrial

- Mobile Homes
- Recreational
- Commercial A
- Commercial-Industrial B
- Business Office District I
- Business Office District II
- Limited Community Shopping District

The majority of the land in proximity to the Salem portion of the I-93 corridor is zoned Commercial-Industrial B and Residential. More specifically, the area south of Rockingham Park Boulevard is zoned Rural or Residential, with the exception of the land which lies between the Spicket River and the Massachusetts state line east of I-93. This area is zoned Highway Commercial. The area adjacent to I-93 between Rockingham Park Boulevard and Brookdale Road is zoned Commercial-Industrial B. The area on either side of Rockingham Park Boulevard is zoned Commercial-Industrial C and a Residential District is sandwiched between this district and the Commercial-Industrial B District adjacent to the Interstate. One of the Town's two industrial districts along Commercial Drive and Northwestern Boulevard is located immediately south of Brookdale Road on the west side of I-93. The area between Brookdale Road and the Windham town line is zoned Rural and Residential.

The generalized purposes of these zones within the I-93 corridor may be characterized as follows:

- *Rural*: Single family residential with 2-acre minimum lot size
- *Residential*: Single family residential with ½-acre minimum lot size
- *Commercial-Industrial B*: Retail, office, manufacturing, assembly, storage uses.
- *Commercial-Industrial C*: Retail, office, manufacturing, assembly, storage uses and child care.
- *Highway Commercial*: Retail and office uses.
- *Industrial*: Office, research, assembly, manufacturing, hotel uses.

3.11.3.2 Windham

The Town of Windham has ten zoning districts:

- Rural
- Residence A
- Residence B
- Residence C
- Neighborhood Business District
- Business Commercial District A
- Business Commercial District B
- Business Commercial District C
- Limited Industrial District
- Historic District

Much of the Windham portion of the study area is zoned Rural. Areas zoned Residence A include the Cobbetts Pond and Canobie Lake shorelines and the Camelot Road/Sheffield Street area between North Lowell Road (Bridge Street) and I-93. Commercially zoned districts include the Windham Depot Neighborhood Business District at the Derry town line; a Business Commercial District B between the northeastern end of Cobbetts Pond and the west side of I-93 at Exit 3; and a

Business Commercial District C zone in the median area south of NH 111 at Exit 3. In addition, Business Commercial District A zones are located in the median area north of NH 111 at Exit 3, on the north side of NH 111 west of the Interstate at Exit 3, and on the north and south sides of NH 111A east of I-93. Within the I-93 corridor, the Historic District includes the Searles School.

The generalized purposes of these zones within the I-93 corridor may be characterized as follows:

- *Rural*: Single family residential with 50,000 square feet minimum lot size (in agricultural landscapes).
- *Residence A*: Single family residential with 50,000 square feet minimum lot size (in residential landscapes).
- *Neighborhood Business District*: Retail, office, restaurant uses.
- *Business Commercial District A*: Business that serves the motoring and transient public.
- *Business Commercial District B*: Business that serves the public.
- *Business Commercial District C*: Business and industrial uses.
- *Historic District*: Historic Commission reviews required.

3.11.3.3 Derry

The Town of Derry has the following seven zoning districts within the study area:

- Low/Medium Density Residential
- Medium/High Density Residential
- Manufactured Housing Park Development
- Office Business District
- General Commercial
- Industrial I
- Industrial IV

The area west of I-93 between the Londonderry and Windham town lines is zoned Low/Medium Density Residential. The entire east side of I-93 through Derry is zoned Industrial to a depth of at least 1,000 feet (Sections 1.260 and 1.280 in the Derry Zoning Ordinance), except for one Medium/High Density Residential district south of Kendall Road. Derry's border with Londonderry, east of I-93, is primarily a combination of Medium/High Density Residential and Industrial, except for NH 102 that is fronted by the Office Business District.

The generalized purposes of these zones within the I-93 corridor may be characterized as follows:

- *Low/Medium Density Residential*: Single family with 2-acre minimum lot size.

- *Medium/High Density Residential*: Single and multi-family with 1-acre minimum lots.
- *Office Business District*: Small retail, office and single family uses.
- *Industrial I*: Manufacturing and open uses, like gravel pits.
- *Industrial IV*: Retail, manufacturing and open uses, like gravel pits.

3.11.3.4 Londonderry

The Town of Londonderry has nine zoning districts:

- Agricultural-Residential
- Residential-II
- Multi-Family Residential-III
- Commercial-I
- Commercial-II
- Commercial-III
- Industrial-I
- Industrial-II
- Conservation

While the majority of the Londonderry portion of the I-93 study area is zoned Agricultural-Residential (AR-I), the Londonderry portion of the study area also includes land zoned for higher density residential, commercial, industrial, and conservation uses. The area between I-93 and the Derry town line at Exit 4 is zoned Commercial-II; the area immediately west of I-93 at Exit 4 is zoned Commercial-I, II and III. The area just south of Exit 5 and NH 28 between the Derry town line and Stonehenge Road is zoned Commercial-II. Land zoned for industrial use includes Industrial-I districts between I-93 and the Derry town line immediately north of Ash Street (east of Exit 4), and the area just northeast of Exit 5. The only Industrial-II district in the I-93 study area is located east of the highway at Exit 5, along the Boston and Maine Railroad. Beaver Brook crosses I-93 near the Derry town line and is zoned Conservation.

The generalized purposes of these zones within the I-93 corridor may be characterized as follows:

- *Agricultural-Residential*: Agricultural and single family uses.
- *Commercial I*: General business uses.
- *Commercial II*: Automotive related uses.
- *Commercial III*: Office uses.
- *Industrial I*: General industrial uses.
- *Industrial II*: General industrial and automotive repair uses.
- *Conservation*: Structures prohibited.

3.11.3.5 Manchester

The City of Manchester has nine residential districts, four business districts, four industrial districts, two civic districts, and one mixed-use district that includes the Millyard Historic District. The Manchester portion of the I-93 study area is zoned

residential. More specifically, the area west of I-93 and south of Crystal Lake is zoned Residential Suburban (R-S), with the exception of the Bryant Road/Skyline Drive area which is zoned One-Family (R-1A). The area north of Crystal Lake to I-293 is zoned One-Family (R-1B). The area east of I-93, between Bodwell Road and the highway, is zoned Multi-family (R-3) and One-Family (R-1A) from just south of the Bodwell Road/Cohas Avenue/Hermit Road intersection north to I-293. East of Bodwell Road is a combination of residential zones, both single and multi-family.

The generalized purposes of these zones within the I-93 corridor may be characterized as follows:

- *Residential-Suburban:* Single family residential with 40,000 s.f. minimum lot sizes.
- *One Family (R-1A)*: Single family residential with 12,500 s.f. minimum lot sizes.
- *One Family (R-1B)*: Single family residential with 7,500 s.f. minimum lot sizes.
- *Multi Family (R-3)*: One and two family residential with 5,000 s.f. minimum lots.

The City does not anticipate any zoning district boundary changes within the I-93 study area.

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3.11.4 Public Utilities

In addition to zoning controls, land development is influenced by the provision of public utilities. Water service relates to potential development density. With public water service, the economics for a higher development density and for non-residential uses desiring a higher level of fire protection are assisted. Development, particularly single family residential development, is not prohibited by the lack of a public water supply. Lack of sewer service combined with soil conditions, on the other hand, may prohibit higher densities due to the large amount of land required for disposal. Additionally, economics plays a part. Without a public system, the development itself must be of a large enough scale to cover the economic cost of a private sewer system. Lastly, natural gas service, which is provided by private corporations, has little affect on housing. It may, however, be an incentive for certain types of industrial and other larger non-residential developments.

3.11.4.1 Salem

The Town of Salem provides drinking water for public distribution throughout its developed area. Excluded, therefore, is the southwestern corner toward Pelham and the northeast area, north of Bluff Road and North Main Street.

Sewerage collection is provided in the center and southeast sections of town. Flow is to, and the treatment is at, the Greater Lawrence Sanitary District in Massachusetts.

Natural gas service, provided by Keyspan Energy Delivery, is available in the South Broadway/I-93 area, on Main Street east to the Municipal offices on Geremonty Drive, in the industrial area west of Exit 2, including Industrial Way, Manor Parkway, Stiles Road and Keewaydin Drive, west a short distance on NH 38 (Lowell Road), and south on Cross Street to serve the industrial area on Garabedian Drive.

3.11.4.2 Windham

The Town of Windham provides neither water or sewer service. The Pennichuck Waterworks, Inc. purchased and now operates several private water systems previously owned by the W & E Water Company. These systems are located in separated neighborhood developments, along NH 111A (Lowell Road) and extending on both sides of the Interstate, in the area of Rock Pond Road further south on NH 111A, on Bridge Street north of the Town Office, and off Fordway on the southern border with Derry. There is neither public sewer service nor natural gas service in Windham.

3.11.4.3 Derry

The Town of Derry purchases water from Londonderry, (that having been purchased from Manchester) and provides for its public distribution throughout the developed area of town east of the Interstate and south down Beacon Hill Road, west of the Interstate.

Public sewer service is provided throughout the built-up area between the Interstate and NH 28 (South Main Street), to the east of the Interstate.

Natural gas service is provided by Keyspan Energy Delivery, along a portion of NH 28 (Rockingham Road), Crystal Avenue and Birch Street, to industrial users just to the west, along most of Tsienneto Street, along Pinkerton Street, and a portion of NH 102 (East Broadway) between NH 28 and NH 28A.

3.11.4.4 Londonderry

The Town of Londonderry is provided water service by both the City of Manchester and Pennichuck Waterworks, depending upon location. Current water service from Manchester is in the airport area and along Litchfield Road to the south, east across Grenier Field Road, to the northeast up Auburn Road and to the southeast down NH 28 (Rockingham Road) to the Derry town line. Pennichuck Waterworks, in turn, serves the southern half of Londonderry, with current service in the southeastern quarter of Londonderry, south of the electric transmission lines paralleling Shasta Drive, west of I-93, and north of South Road.

Public sewer service is found in northwest Londonderry, the area of the airport, east along Grenier Field Road, along Mammoth Drive, Rockingham Road and to the industrial area, just east of I-93 Exit 5. Sewer service extension is planned to go south down Mammoth Road to Pillsbury Road. Public sewer service is also provided on both sides of I-93, Exit 4, serving commercial and industrial uses.

Natural gas is provided by Keyspan Energy Delivery to serve the airport area and extend down NH 28, crossing the Interstate at Exit 5 and continuing to Derry. Natural gas service has recently been provided along Old Derry Road in the northeast corner of Londonderry, by extension south from Bodwell Road in Manchester.

3.11.4.5 Manchester

Manchester provides water service throughout its developed area. This includes the lightly developed area west of I-93, south of I-293 and east of the Mall of New Hampshire and Huse Road.

Sewer service is provided throughout the developed area of central Manchester, north of I-293 and west of I-93. Service extends east of I-93 to serve the East Industrial Park Drive, just north of Island Pond Road and for one 3,300-foot section of South Mammoth Road, south of I-293 and west of I-93. There is also a private force main serving the southern-most subdivision (Rosegate Farm) off Bodwell Road, to the east of I-93.

Natural gas service by Energy North, in the area of the I-93 corridor, comes from East Industrial Park Drive, south along Cohas Avenue, and then along Bodwell Road to the Londonderry town line.

3.11.4.6 Other Utility Services

The Tennessee Gas Transmission Line runs north from Pelham on the Massachusetts border through Manchester. Its closest point to I-93 within the study area is approximately one mile west of Exit 5 in Londonderry where it approximately follows NH 128 (Mammoth Road), crossing from one side to the other.

Major electrical transmission lines cross the Interstate in several locations, all in Londonderry. From south to north, these include a single set of lines just north of Pillsbury Road, four sets of lines just south of Stonehenge Road, and a single set of lines just north of Exit 5.

3.11.4.7 School Bus Routes

Laidlaw Transportation operates four school bus routes for the Town of Derry's Special Education Program that utilize I-93 between Exits 1 and 3, although the morning southbound buses will on occasion detour to local streets to skirt traffic problems to which they have been alerted. The Interstate is also utilized for sporting events and field trips, and by Manchester bus drivers to get to the beginning of a scheduled bus route. Beginning in the fall of 2002, this transportation for Derry's Special Education Program will be provided by a different company.

■

3.11.5 Community Environment

3.11.5.1 Community Facilities

A variety of community facilities are located within or near the municipalities that comprise the I-93 study area. These facilities are described briefly below for each community. The facilities near I-93 are identified in Table 3.11-9 and shown on **Figure 3.11-3**.

Salem

Most of Salem's community facilities are located outside the I-93 study area. Many are clustered in the town center along Main Street (NH 97) and Geremonty Drive, east of I-93. Exceptions to being distant from the Interstate are two schools, the abandoned sewage treatment facility, and the public works yard.

Police

The Salem Police Station is located on Veterans Memorial Parkway approximately 1 mile east of Exit 1, on the east side of NH 28.

Fire

Salem has three full-time manned stations -- the Central Fire Station off Main Street, the North Station in North Salem, and the South Salem Station on Lawrence Road. None of these facilities are located close to the study area.

Schools

Salem has five neighborhood elementary schools (grades 1 - 6) -- Soule School, North Salem School, Fisk School, Haigh School, and Barron School; a junior high school (grades 7-8); and a senior high school. Growth has been accommodated through

Table 3.11-9
Community Facilities in the Interstate 93 Study Area and Vicinity

Salem	Fisk School Soule School Public Works Facility
Windham	Searles Chapel and Conference Center
Derry	Waste Water Treatment Transfer Station Public Works Garage
Londonderry	Town Offices Old Hill Graveyard Sewer Pump Station
Manchester	Green Acres Elementary School Green Acres Middle School Stowell Cemetery

school additions and a sixth elementary school that is being proposed for the northeast section of Town. While none of these facilities are located within the primary study area, Soule School and Fisk School are located in the near vicinity. Soule School is at the intersection of Clough Crossing Road and Kelly Road just south of Exit 1, which is about 1,500 feet east of the Interstate. Fisk School is on Main Street (NH 97) approximately 2,500 feet east of the Interstate and Exit 2.

Municipal Buildings

The Salem Municipal Building, which houses the town's administrative offices, is located in the Town Center Complex on Geremonty Drive, west of Exit 2 and outside the study area. The Municipal Court Building is located in the Town Center Complex adjacent to the Town offices.

Post Office

There are two post offices located in Salem. One, on South Broadway, serves Salem . The other, on East Broadway, serves North Salem.

Hospitals

There are no hospitals in Salem.

Libraries

The Kelley Library is located at the corner of Main Street and Geremonty Drive outside the study area.

Public Works

The Public Works Department is housed at the Cross Street facility just south and east of Exit 1, and immediately adjacent to I-93.

Wastewater Treatment Facility

The wastewater treatment plant was located off South Broadway (Route 28) adjacent to the Spicket River in the south end of town, about 500 feet east of I-93. This facility has now been abandoned and Salem has joined the Greater Lawrence Sanitary District (GLSD).

Windham

Most of Windham's municipal facilities are located in the Church Street—North Lowell Road area off NH 111, approximately one mile west of Exit 3. None of these facilities, except Searles School and Chapel, are located in the study area.

Police

The Windham Police Station had been located west of North Lowell Road on NH 111. A new Police Station has been constructed and is occupied on Fellows Road, the south side of NH 111, opposite North Lowell Road.

Fire

The Windham Fire Department is currently located in the town center next to the Town Hall.

Schools

Two elementary schools -- Golden Brook (grades 1-4) and Center School (grades 4-6) -- and a middle school (grades 7-8) are located in Windham. The Town currently sends its high school students to Salem High School. All of these facilities are located outside the primary study area.

The Windham Cooperative Kindergarten, which used to be located in the Searles Chapel and Conference Center, is a private, non-profit kindergarten and nursery school for children ages 3-6. The kindergarten has now moved to the old Police Station, just west of North Lowell Road on NH 111.

Castle College, a private facility, east of Exit 3, has been closed.

Town Offices

The Windham town offices are located in two buildings in the town center on North Lowell Road, west of I-93.

Post Office

The Post Office is located on Cobbetts Pond Road, that runs between Lowell Road and NH 111A at the south end of Cobbetts Pond. This facility is located outside the primary study area.

Hospitals

There are no hospitals in the Town of Windham.

Libraries

The Nesmith Library was located in the town center on North Lowell Road. A new Nesmith Library has been constructed on Fellows Road, on the south side of NH 111, opposite North Lowell Road.

Museum

The old library building in the town center on North Lowell Road has become the Town's museum.

Other Public Buildings

The Searles Chapel and Conference Center was formerly known as the Searles School, opened in 1909. This facility is located about ½ mile from I-93, on the south side of NH 111, east of Exit 3. This facility is an historic building and includes space for public gatherings, as well as grounds for a soccer field.

Derry

With the exception of the wastewater treatment facility, the solid waste transfer facility, and the public works yard, Derry's community facilities are well outside the I-93 study area.

Police

The Derry Police Department is located near Ross' Corner, east of I-93.

Fire

Derry's central fire station is located on East Broadway. The original fire station is on West Broadway in the center of West Derry, and the Island Pond Fire Station is on the corner of Warner Hill Road.

Schools

Derry has six public schools -- Derry Village School, Floyd Elementary School, Grinnell School, South Range School, Hood Junior High School and West Running Brook Middle School. Pinkerton Academy, also located in Derry, is a private educational facility, contracted by Derry and adjacent communities to provide high school education.

Municipal Building

Some municipal offices are located at the former U.S. Postal Service Building at the corner of Broadway and Crystal Avenue and others are located at 40 Fordway. The Adams Memorial Building on Broadway is used for meeting room facilities and as the Town Office. The District Court that had been in the Adams Memorial Building has been replaced with a new facility on Manning Street.

Libraries

Derry's main Public Library is located on Broadway just west of Crystal Avenue. Taylor Library is located in East Derry.

Hospitals

Parkland Hospital Medical Clinic is located on Parkland Drive, off Birch Street in Derry. This facility is located approximately one mile east of Exit 4.

Post Office

During February 1999, the main Derry Post Office opened at a new location, Tsienneto Road and NH 28 Bypass. Its prior location on Crystal Avenue was a rented facility and remains as a private commercial use. A second post office facility is located on East Derry Road.

Public Works

The Public Works Department is located at 40 Fordway, about ¾ mile east of the Interstate.

Wastewater Treatment Facility

Derry's wastewater treatment facility is located on the Derry-Londonderry town line west of Beaver Brook, immediately east of I-93, just south of Exit 4. This site, at a slightly greater distance from the Interstate, includes Derry's solid waste transfer facility.

Londonderry

Most of Londonderry's municipal facilities are located on Mammoth Road (NH 128). These facilities are well outside the primary study area. Closer to the Interstate are the Town Office and Old Hill Graveyard.

Police

The Police Department is located on Mammoth Road, in what had previously been the Town Office. The school's administrative offices remain at this location.

Fire

Londonderry has three fire stations: the Central Station, on Mammoth Road north of the Library and Town Hall; North Station, on Mammoth Road three miles north of Central Station; and South Station, on Buttrick Road two miles south of Central Station.

Schools

Londonderry has three elementary schools: Matthew Thornton on Mammoth Road near Town Hall; South School, off South Road; and North School, on Rock Road. Londonderry Middle School and Londonderry High School are located on Mammoth Road (NH 128) near Town Hall.

Municipal Building

Londonderry Town Offices are located at 50 Nashua Road (NH 102), approximately one-half mile west of Exit 4.

Post Office

The Post Office is on NH 102, outside the study area.

Libraries

The Leach Library is next to the Police Station on Mammoth Road.

Hospitals

There are no hospitals in Londonderry.

Highway Department

The Londonderry Highway Department is housed in the Town Garage on High Range Road.

Pump Station

The Charleston Avenue sewer pump station is located between Charleston Avenue and the Interstate.

Cemeteries

There are two cemeteries close to I-93. Old Hill Graveyard is on the western side of Hovey Road, north of Exit 4, about 2,000 feet west of the Interstate. Holy Cross Cemetery is a private cemetery and is located on the eastern side of Gilcreast Road, south of Exit 4, about 800 feet west of the Interstate.

Manchester

Manchester is the most urbanized of the five I-93 study area communities. Many municipal facilities are concentrated in downtown Manchester, and others are

scattered throughout the City. Community facilities include police, fire, school, hospital, library, and post office facilities. Manchester's southeast quadrant is one of the City's least developed areas. Thus, few community facilities are located in this area.

Community facilities located closest to the I-93 study area are; Stowell Cemetery, between Bodwell Road and the east side of I-93; and Green Acres Elementary and Middle Schools, located just north of I-293 and west of I-93, where these two highways meet.

Police

Police services are provided to the City from one main station house in downtown Manchester.

Fire

The City of Manchester operates nine fire stations located throughout the City. The Harvey Road Station, west of I-93 and south of I-293 on Harvey Road, is closest to the study area. This station provides first response to the southern and eastern portions of the City. The Fire Department has proposed the construction of two new stations. One of these stations is proposed for the City's southeast area, to be located east of I-93 and just north of I-293 at the intersection of East Industrial Park Drive and Island Pond Road.

Schools

Manchester's public school system is comprised of 15 elementary schools, a sixth grade only school, four middle or junior high schools, three high schools, and one high-school-level school of technology. Of these schools, Green Acres Elementary and Middle Schools are in closest proximity to the study area. They are situated just north of I-293 and west of I-93, and serve the southeast portion of the City.

City Hall

Manchester's City Hall and City Hall Annex are located in downtown Manchester. Many of the City's administrative offices are in these buildings, serving as the focal point of City government.

Post Office

Manchester's post offices are located downtown and off Goffs Falls Road.

Library

The City's main library, Carpenter Memorial Library, is located in downtown Manchester, while a branch library is located on the City's west side.

Hospital

Hospital facilities in Manchester include Catholic Medical Center, Elliot Hospital and Veterans Administration Hospital, all of which are outside the primary study area.

Cemeteries

The only cemetery close to the Interstate is Stowell Cemetery, located on the western side of Bodwell Road, about 300 feet east of the Interstate.

Airport

Manchester Airport straddles the Manchester/Londonderry municipal boundary west of I-93. It is the largest commercial air traffic facility in New Hampshire. Usage of the airport is increasing rapidly and continued growth is anticipated. There is a clear need for improved highway access to the airport to accommodate the existing and anticipated future growth of the airport. Highway access improvements have been under study for the last several years. A separate study is evaluating the selection of a corridor for highway access between the airport and the F.E. Everett Turnpike, west of the Merrimack River. Improved access from the east beginning at Exit 5 of I-93 was considered earlier in the study for improved access to the airport, but was dropped because of impacts and public input.

3.11.5.2 Public Parks and Recreation Land

Section 4(f) Lands

Section 4(f) of the Department of Transportation Act of 1966 states "… special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges and historic sites." Regulations governing 4(f) implementation specify that there can be no taking of public park or recreation lands or impairment of wildlife and waterfowl refuges or historic sites without a thorough investigation into all prudent and feasible alternatives. Such alternatives may range from project modifications to "no build". If it is determined that no prudent and feasible alternatives exist and that public park or recreation lands, wildlife and waterfowl refuges, or historic sites must be acquired or impaired, the FHWA must demonstrate that implementation of other alternatives would result in extraordinary cost, and/or social, economic, or environmental impacts. In addition, the proposed project or program must include all possible planning to minimize harm to the sites.

Park and recreational areas within or adjacent to the I-93 study area are listed in Table 3.11-10 and shown in **Figure 3.11-3**, and briefly described by community. (See Cultural Resource Section for addition 4(f) sites, as well as Chapter 5.

Salem

There is one potential 4(f) park/recreation area in Salem located in proximity to I-93. It is located in Salem on the south side of NH 38 (Lowell Road), about 2,500 feet west of the Interstate. Hedgehog Park, a 28.6-acre park, is used for a variety of canoeing, fishing, swimming, ice-skating, picnicking, horseshoes, volleyball, tetherball, and other recreational activities.

Another recreational facility, owned by the State, is the trail created from a portion of the Boston & Maine Railroad's former right-of-way. This trail begins at the Rockingham Park Boulevard, parallels NH 28 (North Broadway) and continues north into Windham. The Rockingham Recreational Trail is not a potential 4(f) facility in Salem because it is owned by the NH Department of Transportation (NHDOT) as a future transportation corridor, and is on loan to NH Department of Resources and Economic Development (NHDRED) for recreational purposes, until such time transportation improvements are needed.

One private recreational facility, located in the I-93 study area, is the Canobie Lake Fish and Game Club, located on the north side of NH 38 (Lowell Road) opposite Hedgehog Park. Since this club is not a public facility, it is not considered a 4(f) property. Canobie Lake Amusement Park, another private recreational facility, is located on the east side of Canobie Lake, outside of the study area, and is not a 4(f) property.

Windham

Searles Chapel and Conference Center, formerly the Searles School, represents both an historic building and a recreational resource (soccer field) protected by Section 4(f). It is located east of Exit 3. Neither the building nor the soccer field will be impacted by improvements to I-93.

As in Salem, the Rockingham Recreational Trail, owned by the State, is a trail created from a portion of the Boston & Maine Railroad's former right-of-way. This trail continues from the town of Salem, through Windham Depot, to the Town of Derry. This trail is not a potential 4(f) facility, as it is owned by the NHDOT as a future transportation corridor, and is on loan to NHDRED for recreational purposes, until such time transportation improvements are needed.

There was also another railroad right-of-way, sections of which were abandoned in 1935 and 1942, running from Hudson to the northeast, through Windham Depot. This right-of-way owned by the State of New Hampshire has been approved for transfer to Windham. This corridor is not a 4(f) property.

Duncan's Beach in Windham, at the eastern end of Cobbetts Pond, is a private beach and is not, therefore, a 4(f) facility.

Derry

4(f) Properties in Derry include two recreation trails, located east of the I-93 study area. One is an un-named recreational trail, referred to as the B & M Corridor, generally running from the southwest to the northeast in the southern portion of Derry. The other is a portion of another un-named recreational trail. This trail, a continuation of the Rockingham Recreational Trail generally paralleling the Interstate and referred to as the Recreational Corridor, was purchased by the Town from the railroad and is that portion of the Boston & Maine former railroad right-of-way from the Windham town line through the center of Derry and north to Madden Road. The portion of this right-of-way that continues north from Madden Road to the Londonderry town line was not purchased by NHDOT as it shortly runs into the Interstate where it has been blocked. This short northerly portion is still privately owned and is not, therefore, a potential 4(f) facility.

Londonderry

There are no park/recreation facilities identified within the general I-93 study area that could be potential 4(f) properties.

In Londonderry, the abandoned Boston and Maine former railroad right-of-way, owned by NHDOT, is cut off from the south by I-93 and severed by private land sales along the corridor. The right-of-way is not part of the Rockingham Recreational Trail, although it may be used unofficially for recreation.

Manchester

Two City-owned park/recreational facilities are located near the I-93 study area in Manchester: Crystal Lake Park (18.5 acres), at the intersection of Bodwell Road and Corning Road, just several hundred feet west of I-93, and the playing fields at Green Acres Elementary and Middle Schools, just north of I-293 and west of I-93. Crystal Lake Park is a multi-use recreational area used primarily for swimming and boating

Two privately owned recreational facilities are also located in the I-93 study area but are not subject to 4(f) criteria. These include: (1) the Boy Scouts of America's Camp Carpenter (135 acres according to Manchester Planning Department 1981 survey form) located in Manchester approximately ¼ mile east of I-93, at the end of Blondin Road and surrounding the southern half of Long Pond; and, (2) Melody Pines Day Camp, operating June to Labor Day, located on the southern shore of Crystal Lake.

Section 6(f) Lands

Section 6(f) lands are defined as lands that have been acquired or improved with funds provided by the federal Land and Water Conservation Act. The U.S. Department of the Interior, National Park Service has jurisdiction over these lands. Section 6(f) lands cannot be converted to another use without replacement by land that is of comparable value and use. The NH Department of Resources and Economic Development (DRED), Division of Parks and Recreation, maintains a list of lands

acquired or improved with Land and Water Conservation Funds in New Hampshire. A review of DRED's files indicate that two properties located in the I-93 study area qualify as Section 6(f) properties; they are Hedgehog Park in Salem and Crystal Lake Park in Manchester.

Hedgehog Park is a 28.6-acre park surrounding Hedgehog Pond. It is located in Salem on the south side of NH 38 (Lowell Road), about 2,500 feet west of the Interstate. This 28.6-acre park is used for a variety of recreational activities including canoeing, fishing, swimming, ice skating, picnicking, horseshoes, volleyball, and tetherball.

Crystal Lake Park is a 18.5-acre public property located on the north end of Crystal Lake at the intersection of Bodwell Road and Corning Road, just several hundred feet west of I-93. This park is a multi-use recreational area used primarily for swimming and boating.

Open Space Lands

The City of Manchester's Open Space and Recreation Map was produced in 1998 by the Southern New Hampshire Planning Commission for the New Hampshire Land Conservation and Investment Program. There are seven areas listed in Manchester on the Open Space Map. The only one located adjacent to the study area is Great Cohas Swamp. It is located west of I-93 between NH 28A (South Mammoth Road) and NH 28 (South Willow Street), and is adjacent to the Great Cohas Brook. It is outside the I-93 corridor study area. This swamp, however, is in the process of being protected through conservation easements resulting from Manchester's development permit granting process and the efforts of the NH Fish and Game Department.

There are no other listed areas in or near the I-93 study area.

Table 3.11-10
Public Parks and Recreation Areas, Section 4(f) Properties and 6(f) Lands in the Study Area and Vicinity

Salem	Hedgehog Park	4(f) and 6(f)
Windham	Searles Chapel and Conference Center (soccer field)	4(f)
Derry	B & M Railroad Corridor	4(f)
	Recreational Corridor	4(f)
Londonderry	None	
Manchester	Green Acres Elementary and Middle Schools playing fields	4(f)
	Crystal Lake Park	4(f) and 6(f)

3.11.5.3 Commuting Patterns

To understand the potential impact improvements to I-93 may have on the surrounding area, consideration must be given to each community's place within the larger economic environment and to the commuting patterns of the region.

Manchester and its suburbs, due in part to distance and travel time, is largely a self-contained urban economic area, less affected by the Boston Metropolitan area than the remainder of the study corridor. A listing of major manufacturers by location illustrates this economic fact. Manchester, itself, has more job opportunities (59,413) than resident employees (50,999). Even still, 37 percent of its resident employees work outside of Manchester. As a center of an urban economic area, the majority of the commuting from Manchester is to surrounding towns, with only 6 percent of its resident employees commuting to Massachusetts. Manchester's physical development of vacant parcels, as well as its redevelopment, will be much more dependent upon its own economy, and less affected by improvements to this Interstate segment. (See Table 3.11-11 Selected Commuting Patterns and Table 3.11-12 Major Manufacturers by Location.)

Table 3.11-11
Selected Commuting Patterns

Town	# Jobs In Town	# Resident Employees	% In-Town Jobs/ Employee	# Resident Employees Commute Out of Town	% Resident Employees Commute Out of Town	# Resident Employees Work in Massachusetts	% Resident Employees Commute to Massachusetts	% Resident Commuters Commute to Massachusetts
Manchester	59,413	50,999	116.5%	19,192	37.6%	3,163	6.2%	16.5%
Salem	13,727	14,095	97.4%	9,676	68.6%	8,019	56.9%	82.9%
Windham	1,725	4,726	36.5%	3,922	83.0%	2,149	45.5%	54.8%
Derry	6,817	16,409	41.5%	13,089	79.8%	6,584	40.1%	50.3%
Londonderry	6,605	10,660	62.0%	8,536	80.1%	3,340	31.3%	39.1%
Bow	2,242	2,948	76.1%	2,584	87.0%	375	12.7%	14.5%
Hooksett	5,976	4,821	124.0%	3,858	80.0%	195	3.3%	5.1%
Candida	985	1,859	53.0%	1,617	87.0%	130	7.0%	8.0%
Raymond	1,821	4,298	42.4%	3,462	80.5%	520	12.1%	15.0%
Auburn	725	2,179	33.3%	1,882	86.4%	258	11.8%	13.7%
Chester	401	1,455	27.6%	1,169	80.3%	375	25.8%	32.1%
Sandown	354	2,207	16.0%	1,960	88.8%	977	44.3%	49.9%
Danville	242	1,351	17.9%	1,245	92.2%	636	47.1%	41.1%
Hampstead	1,449	3,554	40.8%	2,962	83.3%	1,770	49.8%	59.8%
Atkinson	589	2,890	20.4%	2,638	91.3%	1,566	54.2%	59.4%
Goffstown	3,467	7,550	45.9%	6,069	80.4%	424	5.6%	7.0%
Bedford	10,046	6,581	152.7%	4,845	73.6%	465	7.1%	9.6%
Merrimack	12,311	12,569	98.0%	8,838	70.3%	2,210	17.6%	25.0%
Litchfield	464	3,025	15.3%	2,854	94.3%	556	18.4%	19.5%
Hudson	10,469	10,932	95.8%	8,044	73.6%	3,091	28.3%	38.4%

Source: New Hampshire Commuting Patterns: 1990 Census, NH Employment Security, Economic and Labor Market Information Bureau, August 1994, Revised Nov. 1997.

Table 3.11-12
Major Manufacturers by Location

Company	Address	# Employees	Product
Salem			
Cornucopia Beverages, Inc.	S. Broadway	72	Soft drinks
Data Electronic Devices, Inc.	Bridge Street	50	Contract manufacturer
Hadco Corporation	Manor Parkway	1,700	Printed circuits
Hydroflow, Inc.	Northwestern Blvd.	32	Liquid filtration system
Key Packaging Industries	Garabedian Dr	200	High density plastic blown sheeting
Klein Associates, Inc.	Klein Drive	39	Side scan sonar
Magna Computer Corporation	Keewaydin Dr	57	Computer products
Memtec Corporation	Keewaydin Dr	30	Tape storage devices and wire harness accessories
Micro-Precision Technologies	Manor Pkwy	35	Thick and thin film hybrid circuits
Parlex Corporation	Industrial Way	100	Hybrid thick film product
Salem Screen Printers, Inc.	Delaware Drive	600	Printing
Standex International	Manor Parkway	5,000	Electronic assembly
T L G, Inc.	Keewaydin Dr	30	Portable electronic tactical systems
Turner's Dairy Inc.	Brady Avenue	30	Milk/ice cream mix
Univex Corporation	Old Rockingham	100	Food preparing machine
Windham			
Semiconductor Circuits, Inc.	Range Road	100	Power supplies
Derry			
Dynaco	Tinkham Drive	120	Multilayer and rigid flex circuits
Eastern Rainbow, Inc.	Derry Ind Park	60	Color separations
Galluzzo, Anthony, Corp., The	Chester Road	30	Architectural millwork
Gentex Corporation	Tinkham Ave	35	Electro-acoustic microphones
Hadco Corporation	Manchester Rd	525	Printed circuit boards
McCord Winn	Tinkham Ave	100	Automobile fuel pumps
Merrimack Valley Wood Prod	Derry Ind Park	125	Millwork
Treasure Masters, Inc.	Treasure Lane	200	Gifts, fragrance, jewelry import/export
Londonderry			
AM Technology	Industrial Drive	33	Contract manuf: PCB board assembly
Cadec Systems, Inc.	Perimeter Road	60	In-vehicle computer
Lamont Labs, Inc.	Grenier Field Rd	100	Cleaning chemicals
Nu-Cast, Inc.	Grenier Field Rd	36	Aluminum invest castings
P M C Corporation	Harvey Road	50	Thermocouple and high temperature wire and cable
Prototype Circuits, Inc.	Delta Drive	32	Printed circuit board
Rally Products, Inc.	Hillside Avenue	30	Safety glasses
Surprenant, Albert H.	Harvey Road	50	Kynar and tefzel wire wrap products
Uni Cast	Industrial Drive	110	Aluminum invest castings
Workplace Systems, Inc.	Mammoth Road	39	Modular steel system

Table 3.11-12 (continued)

Company	Address	# Employees	Product
Manchester			
Amherst International Corp.	Commercial St	78	Vinyl/anti-static products
Anchor Electric	Bedford Street	150	Meter mounting and service entrance equipment
Arcadian Manufacturing Co.	Elm Street	40	Plastic heel finishers
Armtec Industries	French Drive	235	Aircraft/industrial fire, pressure, wind sensors/systems
Automatic Data Processing	Gay Street	40	Payroll processing
Blake's Creamery, Inc.	Milford Street	48	Milk, cream products
Budd Food Incorporated	Somerville St	55	Frozen meat pies
Carol Cable Company	McGregor St	450	Electronic cord sets
Caron Box and Lumber	Baker Street	35	Wooden shakes, skids and pallets
Center Services, Inc.	Titus Avenue	250	Contract assembly/packaging
Colortronix	South Willow	35	Color separation
Crosfield Hastech, Inc.	Commercial St	200	Graphic systems for newspapers
Cummings, Lew A., Co., Inc	Canal Street	90	Book and commercial printers
Cushcraft Corporation	Perimeter Road	100	Communication and television antennas
Danais, John, Co.	Shasta Street	30	Laundry and dry cleaning supplies
Deka Research and Develop.	Commercial St	80	Medical equipment and environmental control
Disogrin Industries	Grenier Field	300	Polyurethane seals, wheels and custom molding
Dupont Chemicals	Commercial St	190	Electronics
E P E Corporation	Commercial St	200	Electronic parts/equipment
Easter Seals Society of NH	Auburn Street	225	Contract assembling
Electropac	Willow Street	100	Circuit boards
EPE Technology	Commercial St	115	Pick and place systems, wire wrapping equipment
Felton Brush, Inc.	Wilson Street	160	Industrial appliance bushes
Fiber Processing Corporation	Perimeter Road	36	Recycle wool/other fiber
Fort Howard Corporation	Gay Street	200	Injection molding
G T E Corporation	Willow Street	680	HID lamps
Granite State Manuf Co., Inc.	Joliette Street	105	Electro-mechanical contract mfg
Granite State Packing Co.	Hancock Street	175	Meat packing
Granite Telcom Corporation	Industrial Pk Dr	30	Telecommunication call processing products
H & O Dental Laboratory	Gay Street	70	Dental appliances
Harvey Industries	Huse Road	270	Replacement windows and doors
Hermsdorf Fixture, Mfg. Co.	Franklin Street	110	Store fixtures
Hermsdorf Plastics	March Avenue	40	Custom injected molded plastic
Hitachi Cable Manuf, Inc.	Holt Avenue	105	Non-ferrous wire forgings
Itan Corporation	Commercial Street	50	Vision inspection systems
Jac Pac Foods	Hancock Street	275	Portion control meat
Jewell Electronics Instruments	Grenier Field	150	Digital panel meters, seisonic meters
K R L Electronics	Bouchard Street	85	Wire wound and power resisters
Kalwall Corporation	Candida Road	275	Fiberglass skylights and wall panels
Keller Products, Inc.	Union Street	90	Plastic//wood molding

Table 3.11-12 (continued)

Company	Address	# Employees	Product
Manchester (Cont'd.)			
Kered Clothing, Inc.	Commercial St	65	Contract stitching
Klarmann Rulings, Inc.	PO Box	30	Recticles for optical instruments
Ladesco, Inc.	Dow Street	75	Coil winding
Lafayette Beverages, Inc.	Pepsi Road	110	Soft drinks
Lane Construction Corp., The	Dunbarton Road	40	Bituminous asphaltic concrete
Laurier, Inc.	Industrial Pk Dr	30	Dispensers, hybrid die bonders, chip sorters
Leighton Machine Co.	Rogers&Hayw'd	75	Knitting/custom machines
Manchester Knitted Fashions,	Commercial St	425	Knitted outerwear
Metal Works, Inc.	Gay Street	145	Precision sheet metal
Micro Communications, Inc.	PO Box	30	Waveguide and coaxial RF components
Moore Business Forms & Sys.	Brown Avenue	260	Business forms
New Hampshire Plastics, Inc.	Bouchard Street	100	Plastic sheet extruder
New Hampshire Sunday News	William Loeb Dr	300	Newspaper
Nylon Corporation of America	Sundial Avenue	70	Nylon resins
Protapac Co., Inc.	Willow Street	100	Printed circuit board
R C D Components, Inc.	Industrial Pk Dr	385	Wire wound, precision, specialty resisters
R M Corp.	Zackary Street	36	Circuit board assembly
Signals Communications Corp.	Perimeter Road	75	Communication antennas
Snow-Nabstedt Power Trans.	Joliette Street	100	Industrial power transmissions with reduction gearing
Structures Unlimited, Inc.	Union Street	60	Swimming pool enclosures, structural skylights
Summa Four, Inc.	Sundial Avenue	80	Telephone central office switching peripheral equipment
Summit Packaging Systems, Inc.	Ammon Drive	300	Aerosol valves, contract injection molding
Sweetheart Plastics, Inc.	Gay Street	200	Disposable food containers
T J F Beverages, Inc.	Industrial Drive	170	Soft drink bottler
Therrien A. W. Co.	Hayward Street	35	Sheet metal/ roofing
Union Leader Corp.	William Loeb Dr	300	Newspaper
Velcro U S A, Inc.	Brown Avenue	650	Hook and loop fasteners
Winwood Sportswear, Inc.	Commercial St	50	Sportswear
Zytronics, Inc.	Tirrell Road	60	Electronic power

Source: George D. Hall Company, Directory of New England Manufactures 1993 – 1994, 1993.

The other towns along this Interstate corridor, however, are more tightly related to the Boston metropolitan area, and are what are typically termed as "bedroom communities". The number of Londonderry, Derry, Windham and Salem resident employees that commute to jobs out-of-town range from 69 to 83 percent, more than double the rate for Manchester. At the northern end of this corridor, the commuting destination is split, with 39 percent of the commuters going to Massachusetts and 61 percent remaining in the surrounding towns. This relationship appears to be directly related to the distance of the town from the Massachusetts border. Starting at the

more distant town of Londonderry and progressing through Derry, Windham and Salem, the percentage of resident commuters that commute to Massachusetts are 39, 50, 55, and 83 percent, respectively.

This high rate of Salem resident commuting exists, even as Salem appears to have almost as many jobs in-town as it has resident employees. This appears to be an indication that Salem has become a hybrid economic area, functioning both as a local economic center and as a bedroom community for the Boston metropolitan area. In general, therefore, the Interstate's impact on the development of vacant residential parcels of its corridor towns appears to be related to its real and perceived travel capacity toward the Boston metropolitan area and its many employment opportunities. This would probably be true regardless of the parcel's location from the Interstate, as long as travel time is not perceived to be substantially extended.

Vacant land zoned for nonresidential development within this interstate corridor will also be affected. Non-residential development closely related to the Boston metropolitan area economy (for example, manufacturing one step removed from university research) would attempt to maintain a reasonable proximity relative to time and distance to the Boston metropolitan area. Direct access at interchanges will not be critical, but accessibility for employees and materials will be important. These industries historically were the types of non-residential uses that first migrated to MA 128, then I-495, and more recently into border towns like Salem. As Salem has fewer opportunities, industrial development pressure tends to move northward to Windham, as is currently being reported. Non-residential developments serving a regional population base such as retail facilities, on the other hand, will focus on that population base and desire more direct access to the interstate when considering their locations. These population-based developments deal with location opportunities, visibility and ease of access, with the later developments requiring less direct exit access.

Some of the commuting patterns outside the primary corridor are also likely affected by this Interstate, though much less so. The towns abutting the study area to the north such as Bow, Hooksett, Candida, Raymond and Auburn show high commuting rates (80 to 87 percent), although with only 8 to 15 percent commuting to Massachusetts. This is most likely due to the intervening opportunities of both Concord and Manchester. To the western side of the corridor, Goffstown and Bedford have the same high commuting rates, with only 7 to 10 percent traveling to Massachusetts. As with the northern most towns, there are many intervening employment opportunities.

The towns east of the Interstate corridor, Chester, Sandown, Danville, Hampstead and Atkinson show similarly high commuting rates (80 to 92 percent), but with 32 to 59 percent of commuters traveling to Massachusetts. These towns have fewer in-town jobs, and their residential growth may be affected by I-93, though NH 125's proximity to Interstate 495 through Plaistow provides an alternative access to the Boston metropolitan area.

On the western side of the corridor closer to Massachusetts, Merrimack, Litchfield and Hudson have high commuting rates (70-94 percent), with 19-38 percent of commuters traveling to Massachusetts. This commuting pattern, however, is most likely affecting the F.E. Everett Turnpike, more easily accessed than I-93.

Also to the west is Pelham with a 79 percent commuting rate, and with 72 percent of commuters going into Massachusetts. However, census specific destinations of Lowell and Dracut (69 percent) are more than twice as numerous as those of Andover and Boston (31 percent). The travel direction from Pelham to Lowell and Dracut is away from I-93; and because of road patterns, travel from Pelham to Andover and Boston more than likely joins I-93 within Massachusetts.

3.12 Petroleum & Hazardous Materials and Solid Waste

This section discusses the potential for encountering petroleum, hazardous material release areas, or solid waste sites within the work limits of the alternatives under consideration.

■

3.12.1 Introduction

The identification of confirmed or potential contaminated sites relative to the proposed alternatives is important for the following reasons:

- Potential financial and long-term environmental liability associated with the State's acquisition of a contaminated property;
- Potential delays during construction resulting from discovery of unanticipated subsurface contamination;
- Design changes that may be required as a result of property contamination;
- Defining appropriate Department of Environmental Services (DES) or EPA response actions that may be required to remediate contamination;
- Defining appropriate health and safety provisions to protect workers and sensitive receptors during construction; and
- Demolition of structures that may contain asbestos and other regulated building materials.

■

3.12.2 Methodology

To assess the potential presence of petroleum or hazardous material releases, searches of available environmental databases were performed. The databases provide information related to confirmed release sites and sites that may have the potential for encountering contamination. Additional sources of information were consulted, which included the following:

- Department of Environmental Services, Waste Management Division, list of "CERCLIS Sites" (March 26, 1992);
- Department of Environmental Services, Waste Management Division, list of hazardous waste generators (September 18, 1992);
- Department of Environmental Services, Groundwater Protection Bureau, listing of sites (July 2, 1992);
- Department of Environmental Services, Waste Management Division, list of "solid waste" sites (April 10, 2003);
- Department of Environmental Services, Waste Management Division, list of "MSW Incinerators" Operating in 2001 (November 2001);
- Department of Environmental Services, Waste Management Division, list of used "tire sites" (December 4, 2001);
- Department of Environmental Services, Waste Management Division, list of "MSW and ash landfills" operating in 2001 (August 2002);
- Department of Environmental Services, Waste Management Division, list of collection, storage, and "transfer facilities" (September 2002);
- Department of Environmental Services, Waste Management Division, list of "infectious waste incinerators" operating in 2001 (August 2002).
- Department of Environmental Services, Waste Management Division, list of "composting facilities" (September 4, 2001);
- Department of Environmental Services, Waste Management Division, email of "Asbestos Disposal Sites (ADS)" in Salem, Derry, Londonderry and Manchester, Waste Management Division (June 3, 2003);
- Department of Environmental Services, Waste Management Division, list of "Materials Recovery Facilities (MRF)" (January 14, 2003); and
- Site reconnaissance of project corridor to identify suspect properties not identified in environmental databases.

Based on the databases, findings and subsequent field reconnaissance, 83 properties were identified within an approximate 1,000-foot radius of the I-93 corridor between Salem and Manchester. Table 3.12-1 includes the summary of the 83 properties. The locations of the properties identified in Table 3.12-1 are shown on **Figure 3.12-1**.

Table 3.12-1
Confirmed or Potential Contaminated Sites within Approximately 1,000 Feet of I-93 Corridor

City	NHDES ID Number	Site Address	Database	Status	ID*
Salem	NHD986474351	Industrial Way	RCRA-VG	NA	20
Salem	**NHD986468676**	**Raymond Avenue**	**RCRA-VG**	**NA**	**10**
Salem	NHD980525646	Pelham Road	RCRA-SG	NA	35
Salem	NHD981071459	Garabedian Drive	RCRA-SG	NA	3
Salem	NHD986472728	Industrial Way	RCRA-SG	NA	21
Salem	NHD986474377	Raymond Avenue	RCRA-SG	NA	11
Salem	**NHD039129440, 0-110941, 199209021**	**Northeastern Boulevard**	**RCRA-SG, UST (1998), GPB**	**LUST, AST**	**25**
Salem	911003	Lowell Road	GPB	Site Eval	5
Salem	**NHD073976904, 0-110568, 88011**	**Northeastern Boulevard**	**RCRA-LG, UST (1998), GPB**	**Haz Waste, LUST, Site Eval**	**26**
Salem	**NHD980523732**	**Keewaydin Drive**	**RCRA-SG**	**NA**	**15**
Salem	**NHD120550967**	**Lowell Road**	**RCRA-SG SPILLS (1998), UST (1998)**	**NA**	**60**
Salem	NHD981214315, NHD980668156, 840522, 198405022	Manor Parkway	RCRA-VG, RCRA-LG, GPB (1992) RCRA-SG (1998), Haz Waste, UST (1998)	Haz. Waste	23
Salem	NHD986473122	Industrial Way	RCRA-VG	NA	22
Salem	8405023	Pelham Road	GPB	Site Eval	18
Salem	**NA**	**Raymond Avenue**	**NA**	**NA**	**81**
Salem	**840527**	**Keewaydin Drive**	**GPB, SW**	**Haz. Waste, Inactive Solid Waste Site**	**14**
Salem	840524	Lowell Road	CERCLIS GPB	Land/ Unlined	7

Table 3.12-1 (continued)

City	NHDES ID Number	Site Address	Database	Status	ID*
Salem	0-112829	Main Street	UST	NA	12
Salem	NHD982747347	Pelham Road	RCRA-SG	NA	19
Salem	NHD980525430	Keewaydin Drive	RCRA-SG	NA	16
Salem	**NHD986471779**	**Industrial Way**	**RCRA-VG**	**NA**	**61**
Salem	NHD986484061	Rockingham Park Blvd.	RGRA-SG	NA	9
Salem	0-114680	Rockingham Park Blvd.	UST	NA	9
Salem	0-113610, 199509022	Rockingham Park Blvd.	UST, GPB	LUST	9
Salem	**NHD500003553, 199003010**	**Cross Street**	**RCRA-SG, GPB**	**LUST**	**4**
Salem	198710007	Lowell Road	GPB	SEPT/LAG, Haz Waste	17
Salem	**8405033, 0-114121**	**Garabedian Drive**	**CERCLIS GPB, UST (1998)**	**Haz Waste**	**1**
Salem	NHD986474203	Rockingham Park Boulevard	RCRA-SG	NA	9
Salem	NHD988470193, 0-114753	Manor Parkway	RCRA-SG, UST (1998)	NA	24
Salem	NHD095513602, 199311018, 93-495	Lowell Road	RCRA-SG (1992), RCRA-VG (1998), UST (1998), GPB, SPILLS (1998)	LUST	8
Salem	NA	19-23 Keewaydin Drive	ADS	Asbestos Disposal Site	83
Windham	880838	Range Road	GPB	Haz Waste/ WM	28
Windham	**900731**	**Off Searles Road**	**GPB**	**Spray irrig, UWW/LAG**	**32**
Windham	900801, 0-112563, 0-112114	NH 111	GPB, UST	LUST/UIC	30
Windham	NA	NH 111	NA	NA	82

Table 3.12-1 (continued)

City	NHDES ID Number	Site Address	Database	Status	ID*
Windham	**NA**	**Range Road**	**NA**	**NA**	**78**
Windham	**NA**	**Range Road**	**NA**	**NA**	**77**
Windham	**920509, 0-113880**	**NH 111**	**GPB, UST**	**LUST**	**31**
Windham	**901048, NHD000845636, 0-113907**	**NH 111/I-93**	**GPB, RCRA-VG, UST**	**ODD**	**29**
Derry	920620	Kendall Pond Road	Spill/RLS	Closed	34
Derry	8706012, NHD980523328, 198706001	Kendall Pond Road	CERCLIS, GPB, RCRA-SG, LUST	LAND/ Unlined	33
Derry	NHD981070972 840136, 0-113467	Broadway Street	RCRA-SG GPB, UST (1998)	LUST	33
Derry	**840135**	**Bridge Street**	**GPB**	**UWW LAG**	**37**
Derry	NHD981884240	Aiken Street	RCRA-SG	NA	41
Derry	871220	Bridge Street	GPB, SW	Transfer Station, Capped Landfill	36
Derry	NHD00084626	Aiken Street	RCRA-SG	NA	42
Derry	NA	NH 102	UST	NA	74
Derry	NA	NH 102	UST	NA	75
Derry	NA	Kendall Pond Road	NA	NA	80
Londonderry	481258	Liberty Drive	ERNS	NA	55
Londonderry	**0-113761**	**West Broadway**	**UST**	**NA**	**38**
Londonderry	0-110807	Liberty Drive	UST	NA	62
Londonderry	**NHD012040275 900817**	**NH 102**	**RCRA-SG GPB**	**LUST**	**40**
Londonderry	NHD986469427	Symmes Drive	RCRA-VG	NA	58

Table 3.12-1 (continued)

City	NHDES ID Number	Site Address	Database	Status	ID*
Londonderry	NHD98648395 53659, 199606052	Symmes Drive	RCRA-SG ERNS, GPB	AST, LUST	63
Londonderry	**NHD981203284**	**Rockingham Road**	**RCRA-SG**	**NA**	**68**
Londonderry	NHD982198475	Liberty Drive	RCRA-SG	NA	53
Londonderry	**0-114012, 199407075**	**Londonderry Road**	**UST, GPB**	**AST**	**46**
Londonderry	890758	Independence & Liberty Drive	GPB	Holding tank	54
Londonderry	**920328**	**I-93, vicinity Exit 5**	**GBP**	**SPILL/ RLS**	**57**
Londonderry	**NHD982749970 840329**	**Londonderry Road**	**RCRA-SG GPB**	**UIC**	**45**
Londonderry	NHD982202509	Londonderry Road	RCRA-SG	NA	44
Londonderry	NHD986485803	Garden Lane	RCRA-SG	NA	48
Londonderry	**NHD982193062, D50157**	**Route 102**	**RCRA-SG, ERNS**	**NA**	**50**
Londonderry	**NA**	**Route 102**	**UST**	**NA**	**50**
Londonderry	NHD081250367	Stonehedge Road	RCRA-SG	NA	51
Londonderry	**NHD986481877 910217**	**Route 102**	**RCRA-SG GPB**	**LUST**	**39**
Londonderry	NA	Londonderry Road	NA	NA	76
Londonderry	NHD986474211, 449532, R51258, 448596	Londonderry Road	RCRA-SG (1992), RCRA-VG (1998), ERNS	NA	43
Londonderry	**NHD043160605**	**Ash Street**	**RCRA-SG**	**NA**	**47**
Londonderry	**530973, 199804014**	**Rockingham Road**	**ERNS, GPB, SW**	**Transformer, Spill / RLS**	**52**
Londonderry	**NA**	**Rockingham Road**	**UST**	**NA**	**67**
Londonderry	NHD062004569, 199004008, 93-316	Route 102	NPL, GPB, SPILLS	CERCLA	64

Table 3.12-1 (continued)

City	NHDES ID Number	Site Address	Database	Status	ID*
Londonderry	NHD986471076, 199502042	Perimeter Road	RCRA-SG/LG, GPB	HOLDTANK/RLS	56
Londonderry	0-111372	Route 102	UST	NA	49
Londonderry	NA	Independence Drive	NA	NA	69
Londonderry	NA	I-93	Spill	NA	70
Londonderry	NA	Route 102	UST	NA	71
Londonderry	NA	Route 102	NA	NA	72
Londonderry	NA	Route102	UST	NA	73
Londonderry	**0-114599**	**Route 28**	**UST**	**NA**	**66**
Manchester	880520	Mammoth Road	GPB	NA	79
Manchester	NHD052017787	Island Pond Rd.	RCRA-VG	NA	59

Notes: Bolded rows represent properties for which ISA's were performed.

GPB – Groundwater Protection Bureau
UIC – underground injection control,
LUST – leaking underground storage tank
UST – underground storage tank
RCRA – Resource Conservation and Recovery Act
SG – small quantity generator
VG – very small quantity generator
LG – large quantity generator
AST – aboveground storage tank
WM – waste management
RLS – Release
SLU – Sludge
LAG – Lagoon
UWW – Untreated Wastewater
ERNS – Environmental Release Notification System
ODD – Oil Discharge and Disposal/Cleanup Fund Site
Land/Unlined – Unlined Landfill
NA –Not Available / Not Applicable
SW – Solid Waste Site
ADS – Asbestos Disposal Site
* - See **Figure 3.12-1** for Site locations

From this list, 29 properties were selected for Initial Site Assessments (ISAs) to be conducted. The properties were selected based on an approximate 500-foot distance from the I-93 corridor, a limited site reconnaissance (windshield survey), information obtained from files reviewed at the NHDES related to State Hazardous Waste Sites (SHWSs), and current property use (i.e., gasoline stations, automotive repair facilities). The 29 sites are bolded in Table 3.12-1.

■

3.12.3 Summary of Initial Site Assessment (ISA) Findings

Individual Site Assessments (ISAs) are initial investigations, using primarily local, state and federal data bases and files to determine whether a property may be contaminated. The results of the ISA's were documented in a comprehensive report dated February 2002. A summary of the ISA findings for each of the 29 properties is included in the following Table 3.12-2.

Table 3.12-2
Summary of ISA Findings

City	Site Name/Address	ISA Findings	Figure 3.12-1 ID
Salem	Raymond Avenue	2 RCRA Generators, no violations reported.	10
Salem	Northeastern Boulevard	UST Site, RCRA Generator, no violations reported, Remediation completed in 1996.	26
Salem	Northeastern Boulevard	UST Site, RCRA Generator, no violations reported, Remediation completed in 1994.	25
Salem	Keewaydin Drive	RCRA Generator, no violations reported.	15
Salem	Lowell Road	UST Site, RCRA Generator, no violations reported.	60
Salem	Keewaydin Drive	Active Remediation Site, currently under a Groundwater Management Permit.	14
Salem	Industrial Way	RCRA Generator, no violations reported.	61
Salem	Cross Street	LUST Site, RCRA Generator, USTs removed, Diesel contamination in soil and groundwater.	4
Salem	Garabedian Drive	Currently under an ISA being conducted by Jacques Whitford Company.	1
Salem	Raymond Avenue	Former spill from on-site UST and potential migration of contaminants in groundwater from an off-site source.	81
Windham	Off Searles Road	Wastewater treatment system on-site, Active Remediation Site, currently under a Groundwater Management Permit.	32
Windham	Route 111	LUST Site, MTBE in bedrock potable water well, Groundwater Management Zone not yet established.	31
Windham	Route 111	LUST Site, Active Remediation Site, currently under a Groundwater Management Permit.	29
Windham	Range Road	No potential environmental concerns noted.	78
Windham	Range Road	Potential for former automotive maintenance and sealed floor drain present.	77
Derry	Bridge Street	Former landfill capped, wastewater lagoons reconstructed, currently under Groundwater Management Permit.	37
Londonderry	West Broadway	UST Site, 7 USTs installed in 1985 and all 7 removed in 1995.	38
Londonderry	Route 102	LUST Site in 1993, no detectable contaminant concentrations in 1994, TCE in groundwater from former upgradient dry-cleaner.	40
Londonderry	Londonderry Road	UST Site, permanently closed USTs in 1986.	46
Londonderry	Route 93, vicinity of Exit 5	5,000 – 7,000-gallon gasoline spill in I-93 median in 1996. Spilled to frozen ground, remediation completed in 1996.	57
Londonderry	Londonderry Road	Commercial / Light Industrial building on septic system.	45
Londonderry	Route 102	UST Site, several USTs closed in 1994 with no available documentation. Auto repair facility on a septic system until 1995.	50
Londonderry	Route 102	LUST Site, Active Remediation Site, currently under a Groundwater Management Permit.	39

Table 3.12-2 (continued)

City	Site Name/Address	ISA Findings	Figure 3.12-1 ID
Londonderry	Ash Street	Auto Repair Facility on a septic system since 1977.	47
Londonderry	Rockingham Road	UST Site, 2 spills in 1997 and 2000, both spills are listed as "Closed".	66
Londonderry	Rockingham Road	Waste management facility with the presence of landfill and groundwater contamination.	52
Londonderry	Rockingham Road	Gasoline station with documented release from USTs. Existing GMZ to address BTEX and MTBE in groundwater.	67
Londonderry	Rockingham Road	Exiting motor cycle service and sales. No environmental concerns noted.	68

■

3.12.4 Potential Building Acquisition and Demolition

In addition to addressing properties that may be contaminated as a result of a release of petroleum or hazardous materials, the project alternatives may also include the acquisition of property that would require the demolition of existing buildings and structures. The buildings may contain regulated materials that require removal prior to demolition. Based on the age of the buildings, regulated materials may include the following:

- Asbestos
- Lead-based paint
- Polychlorinated biphenyls (PCBs) within fluorescent light ballasts
- Electrical transformers that may contain PCB dielectric oil
- Mercury-containing fluorescent light bulbs
- Mercy thermostats
- Miscellaneous containers of oil or hazardous materials
- Refrigerants (air conditioners, refrigerators)
- Hydraulic lifts
- Aboveground storage tanks
- Underground storage tanks

Based on a review of the proposed alternatives, 49 properties contain up to 55 structures that may require demolition. The 49 properties that could be affected by any of the alternatives are listed in Table 3.12-3.

Table 3.12-3
Buildings that may Require Demolition

NH DOT Parcel ID	Address	Property Use	Structure(s)	Figure 3.12-1 ID
Salem				
S10	Valeska Lane	Residential	House, Garage	NA
S17	Cross Street	Residential	House, Garage	NA
S37	Cross Street	Residential	House	NA
S38	Brady Avenue	Residential, Vacant	Building	NA
S42	Williston Road	Residential	House	NA
S43	Williston Road	Residential	House	NA
S60	Lowell Road	Residential	House	NA
S69	Lowell Road	Residential	House	NA
S78	Pelham Road	Residential	House	NA
S81	Main Street	Commercial	Building	NA
S151	Fairmont Road	Residential	House	NA
S152	Fairmont Road	Residential	House	NA
S153	Fairmont Road	Residential	House	NA
S154	Fairmont Road	Residential, Vacant	House	NA
S155	Boyer Lane	Residential	House, Garage	NA
S156	Fairmont Road	Residential, Vacant	House	NA
S157	Fairmont Road	Residential	House	NA
S158	Fairmont Road	Residential	House	NA
S169	Boyer Lane	Residential	House	NA
S173	Raymond Avenue	Industrial	Building	81
S178	Trolley Lane	Residential	House	NA
S182	Trolley Lane	Residential	House, Structure	NA
Windham				
W35	NH 111	Commercial	Building	82
W42	NH 111	Commercial	Shed	NA
W43	NH 111	Commercial	Building	NA
W44	NH 111	Commercial	Building	31
W45	NH 111	Residential	House	NA
W46	NH 111	Residential, Vacant	House	NA
W47	NH 111	Residential, Vacant	House	NA
W95	NH 111	Commercial	Building	NA
W99	NH 111	Commercial	Building	29
W100	NH 111	Commercial	Building	NA
W102	NH 111A	Residential	Building	NA
W103	NH 111A	Commercial	Three Buildings	NA
W104	NH 111A	Commercial	Building	78
W105	NH 111A	Commercial	Building	NA
W106	NH 111A	Commercial	Building	77
Derry				
D10	Spinnaker Drive	Residential	House	NA
D11	Spinnaker Drive	Residential	House	NA

Table 3.12-3 (continued)

NH DOT Parcel ID	Address	Property Use	Structure(s)	Figure 3.12-1 ID
Londonderry				
L37	Trolley Car Lane	Residential	House	NA
L75	Rockingham Road/ Symmes Drive	Commercial	Building	NA
L79	Rockingham Road	Commercial	Building	68
L80	Rockingham Road	Commercial, Vacant	NA	NA
L81	Rockingham Road	Commercial	Building	67
L82	Rockingham Road	Commercial	Two Buildings	52
L130	Rockingham Road	Commercial	Building	66
L174	Londonderry Road	Commercial	Building	76
L178	Reo Lane	Residential	House	NA

4

Environmental Consequences

4.1 Introduction

This chapter describes the impacts associated with each of the alternatives that were carried forward for further study (see Section 2.5). A concise summary of this chapter was provided in Section 2.6.

4.2 Traffic Impacts

This section describes the future traffic volume condition and summarizes the traffic operating conditions for each of the proposed alternatives. Alternatives include the No Build condition as a base comparison, various highway widening alternatives from the existing two lanes in each direction to either three and/or four lanes in each direction, various interchange configuration options, Transportation System Management (TSM) options to accommodate interim improvements at selected locations, and Transportation Demand Management (TDM) measures.

The criteria used for evaluation are described below.

■

4.2.1 Traffic Criteria

This section describes the procedure used to establish an appropriate design hour volume condition, describes the level of service methodology used for evaluation, and presents the procedure used to determine the basic lane requirements for the highway.

4.2.1.1 Design Hour Volumes

The first step in evaluating the alternatives under a future traffic volume condition is to establish an appropriate traffic volume condition. As described in Section 3.2.2, the 30th highest hour volume is used as the appropriate design hour volume for the segments of I-93. The 30th highest hour volume is used for design purposes because it is a volume level that is not exceeded very often (only 29 other hours a year), while

on the other hand, it is not so high that full use of the facility would only rarely occur.

Based on the data provided at the New Hampshire Department of Transportation (NHDOT) permanent count station located on I-93 in Derry, the 30th highest hour volume is approximately 9.4 percent of the ADT. The Directional Design Hour Volume (DDHV) split shows approximately 60 percent of the total hourly traffic traveling in the peak direction.

The DDHV, which is neither specifically a morning (AM) nor an afternoon/evening (PM) volume, is the design volume in the peak direction that is used to evaluate the segments of I-93 and to determine basic lane requirements. AM and PM peak hour volumes are used to evaluate interchange and intersection movements. The use of DDHV for mainline analysis and AM and PM peak hour volumes for intersection design is in keeping with national standards.

4.2.1.2 Levels of Service

A level of service analysis, similar to the procedure used to evaluate the existing condition (described in Chapter 3) was conducted for the corridor segments, interchanges, and intersections. Six levels of service are defined ranging in letter designation from LOS A to LOS F, with LOS A representing the best operating condition and LOS F representing the worst. LOS C describes a stable flow condition and is considered desirable for peak or design hour traffic flow. LOS D is generally considered acceptable where the cost and impacts of making improvements to provide LOS C are deemed unjustifiable. Level of service E is capacity. The traffic performance measures, and the evaluation criteria used in the operational analyses, are based on the methodology presented in the 2000 Highway Capacity Manual.[37]

In the design of new roadway facilities, the NHDOT has established LOS C as desirable and LOS D as minimally acceptable. However, despite establishing LOS D as the minimally acceptable level of service, the NHDOT has also expressed a general policy of not constructing highways with more than eight basic lanes (four lanes in each direction).[38] An eight-lane facility is the widest configuration that the NHDOT considers appropriate for New Hampshire. Therefore, for the purpose of this evaluation, the objective is to provide at least a LOS D operation in the year 2020 while constructing no more than four basic lanes in each direction.

In addition to the freeway and interchange (merge, diverge and weave) operations, an operational analysis was conducted at signalized and unsignalized intersections

37 2000 Highway Capacity Manual, Special Report 209, Transportation Research Board, Washington, D.C.
38 Continued widening beyond 8 lanes is not considered a feasible and prudent option to address future long-range transportation needs in the corridor. If Massachusetts were to widen beyond 8 lanes, a transition would be necessary between the two states.

located at or near the corridor interchanges for each of the Build Alternatives and for various options. For signalized intersections, level-of-service is based on the delay in seconds experienced by motorists at an intersection. A secondary performance measure, which is not directly related to level-of-service, is the volume-to-capacity (v/c) ratio. The results of the operational analyses at signalized intersections are presented in terms of LOS, delay, and v/c ratio. The relationship between delay and LOS is summarized in this table.

LOS	Delay (Seconds)
A	≤ 10
B	> 10-20
C	> 20-35
D	> 35-55
E	> 55-80
F	> 80

The results of the operational analyses at unsignalized intersections are presented in terms of LOS, delay, and demand. The relationship between delay and LOS is summarized in this table.

LOS	Delay (Seconds)
A	0 - 10
B	> 10 - 15
C	> 15 - 25
D	> 25 - 35
E	> 35 - 50
F	> 50

4.2.1.3 Basic Lane Criteria

The basic lanes of a highway are the travel lanes along a facility that are needed solely to accommodate the movement of through traffic. Basic travel lanes do not include traffic management lanes such as climbing lanes, acceleration/deceleration, collector/distributor, weaving, and merging type lanes, which may be needed in the vicinity of an interchange to accommodate vehicles entering and exiting the highway. These basic lanes serve to provide a consistent number of lanes over a substantial length of highway.

To determine the number of basic lanes that will be needed to accommodate traffic flow along the I-93 study corridor, the level of service criteria was applied to the future year design hour traffic volumes. Each segment of the corridor was

evaluated to determine the number of basic lanes that would be needed to provide at least a LOS D operation during the design hour (30th highest volume) in the year 2020.

■

4.2.2 Traffic Model

The purpose of this section is to document the methodology used to develop the traffic volume projections for the study corridor. Specifically, this section describes the development of the I-93 sub-area traffic model that serves as the basis for the traffic volume projections in this report.

In 1994 the NHDOT began an important statewide study to carry the Department's transportation planning into the 21st century. The overall goal of the Statewide Planning Study was to "provide recommendations for developing a coordinated transportation system that would facilitate the movement of persons and goods in a safe, cost-effective, efficient, and environmentally conscious manner." Recommendations from this study were to be directed to all transportation modes in the State of New Hampshire, including highways and public transportation.

The New Hampshire Statewide Travel Demand Model System (NHSTMS) was developed as part of this study. The model helps predict travel behavior (i.e., how people travel by car, bus, etc.) and travel demand (i.e., how many people want to travel on a certain road or by a certain mode). The model is based on statewide data collected on highway, bus, and rail systems, and on land use, and social and economic characteristics. Household travel, roadside motorist, and transit rider surveys were conducted as part of the data collection effort in 1994. The model is intended to identify potential new or improved transportation services and strategies, in an effort to improve overall transportation services, reduce congestion and improve air quality.

The NHSTMS is a tour-based model system consisting of many sub-models, or components. The system is intended to model travel by auto and transit modes for a summer weekday. The base year of the model is 1990 with analysis capabilities for all forecast years ranging from 1997 to 2020, although years beyond 2020 could be analyzed using extrapolation of socio-economic forecasts.

The I-93 sub-area is one of the sub-models or components of the statewide model. The I-93 sub-area model is more detailed, that is, it has smaller, and consequently more, traffic zones and somewhat finer highway networks than the statewide model. The zones and the highway network for the I-93 sub-area model were developed in consultation with the appropriate regional planning commissions, local officials and others. The zones and the network for the I-93 sub-area model are consistent with the statewide overlapping regional models. All links in the statewide transportation network, which are located in the I-93 sub-area, are included in the model.

The trip tables for the I-93 sub-area model were developed from the statewide model. These trip tables were imported into the sub-area model and then traffic assignments were made for the sub-area. The 1997 base year sub-area model was considered to be calibrated when the traffic assignments reasonably reflected the traffic volumes estimates from the NHDOT statewide model on I-93 from the state line to the I-93/I-293 split in Manchester.

Based on the guidelines published in the Federal Highway Administration's Report *Calibration and Adjustment of System Models*[39], the 1997 sub-area model traffic assignments fell within the acceptable range of accuracy for freeways. Similarly, the sub-area model assignments for other major roadways such as NH 28, NH 111, and NH 102 were also compared to actual 1997 data and were determined to be within the acceptable range of accuracy for these types of facilities. Therefore, with the model calibrated, it was determined that the 1997 sub-area model accurately reflects the actual traffic volume conditions within the project area and could be used for planning and forecasting purposes.

Traffic forecasts were made for year 2020 for the I-93 sub-area using the model. The 2020 highway network includes proposed improvements (expected to be completed by 2020) such as the I-293 reconstruction, the Manchester Airport Access Road, the Nashua Circumferential Highway, and the F.E. Everett Turnpike expansion. Traffic forecasts from the I-93 subarea model were compared with traffic forecasts for 2020 from the Southern New Hampshire Planning Commission model, the Manchester Airport Access Model, the Windham-Salem NH 111 model, and the Nashua Regional Planning Commission model, and correlations were found to be acceptable.

■

4.2.3 No-Build Alternative

The No-Build Alternative is essentially the continuation and perpetuation of the existing situation and the shortcomings inherent on the present highway corridor. The No-Build Alternative will serve as a baseline condition for comparison with other alternatives.

The projected 2020 No-Build ADT, DHV and, most importantly for determining the number lanes needed, DDHV for each segment of the corridor are shown in Table 4.2-1. The 2020 future morning and evening peak hour volumes at each of the study corridor interchanges and intersections are shown in **Figures 4.2-1 and 4.2-2**.

As shown in the table, the projected 2020 DDHV ranges from a low of 4,100 vehicles per hour (vph) between Exits 3 and 4 to a high of 7,700 vph south of Exit 1.

▼

39 Calibration and Adjustment of System Models, Federal Highway Administration, December 1990.

Table 4.2-1
2020 Average Weekday and Design Hour Volumes (No Build)

Segment	ADT[1]	DHV[2]	DDHV[3]	LOS[4]
South of Exit 1	137,000	12,900	7,700	F
Between Exits 1 and 2	103,600	9,700	5,800	F
Between Exits 2 and 3	98,000	9,200	5,500	F
Between Exits 3 and 4	73,000	6,900	4,100	E
Between Exits 4 and 5	81,200	7,600	4,600	E
North of Exit 5	84,300	7,900	4,800	F

1 ADT – Average Daily Traffic
2 DHV - Design Hour Volume
3 DDHV - Directional Design Hour Volume
4 LOS – Level-of-Service

The results of the operational analyses indicate that to provide at least a LOS D operation in 2020 would require the following number of basic lanes along the corridor.

- 10 lanes (5 lanes in each direction) south of Exit 1,
- 8 lanes (4 lanes in each direction) between Exit 1 and Exit 3, and
- 6 lanes (3 lanes in each direction) between Exit 3 and I-293.

Again, the basic lane requirements are the number of basic lanes, exclusive of traffic management lanes, that are needed to accommodate through traffic along each segment of the I-93 corridor. Note that to provide a LOS D operation along the segment south of Exit 1 would require a five-lane section. This exceeds the NHDOT's general policy of not constructing highways with more than four basic lanes in each direction.

The results of the operational analyses for the 2020 No-Build condition, as summarized in **Figures 4.2-3**, reveal poor operating conditions (LOS E or F) for all segments of the I-93 study corridor from Salem to Manchester. Similarly poor operating conditions would occur at most interchange movements with at least one ramp movement showing a failure condition (LOS F) at every study area interchange. Poor operations, or capacity conditions are projected at each of the signalized intersections at Exit 2, Exit 3, and Exit 5. The signalized intersections at the Exit 4 northbound and southbound ramps show LOS D or better.

In summary, as the volume of traffic continues to increase in the future, under the 2020 No-Build condition, the delays and congestion experienced along the I-93 corridor and at each of the corridor interchanges will not only worsen during the peak hours, but the level of congestion is expected to expand to longer periods of the day and to a greater number of days during the year.

■

4.2.4 Build Alternatives

4.2.4.1 Freeway Segment Operations

There are three Build Alternatives that consider the widening (adding lanes) of I-93. The alternatives are:

- Widen I-93 to 4 lanes in each direction for the entire length of the corridor.
- Widen I-93 to 3 lanes in each direction for the entire length of the corridor.
- Widen I-93 to 4 lanes through Exit 3 and to 3 lanes north of Exit 3.

Tables 4.2-2 and 4.2-3 present the average daily traffic, directional design hour volumes, and operating levels of service for the 2020 No Build and the 2020 3 and 4-lane Build alternatives. As shown in Table 4.2-3, the 3-lane cross section would provide at least LOS D (the established minimally acceptable condition) for each of the segments north of Exit 3, however the segments south of Exit 3 would operate at LOS E (capacity) or LOS F (failure condition).
Under the 4-lane alternative, the segments north of Exit 2 would operate at LOS C (the established desirable condition) or better with the segment between Exit 1 and Exit 2 operating at LOS D. Note that the segment between the state line and Exit 1 would operate at LOS E under the 4-lane alternative. A 5-lane (each direction) cross section would be needed along the segment south of Exit 1 to provide a LOS D operation. However, a 5-lane section would exceed the NHDOT's position of not constructing highways with more than 4 basic lanes in each direction.

Table 4.2-2
Freeway Segment Average Daily Traffic
2020 No Build and 2020 Build – Three-Lane and Four-Lane Alternatives

Segment	No-Build	Build Three-Lanes	Build Four-Lanes
MA State Line to Exit 1	137,000	142,200	143,600
Exit 1 to Exit 2	103,600	114,300	116,500
Exit 2 to Exit 3	98,000	107,100	108,900
Exit 3 to Exit 4	73,000	75,900	76,600
Exit 4 to Exit 5	81,200	84,400	85,200
North of Exit 5	84,300	87,900	88,900

Table 4.2-3
Freeway Segment Analysis Summary
2020 No Build and 2020 Build – Three-Lane and Four-Lane Alternatives

	No-Build		Three-Lanes		Four-Lanes	
Segment	DDHV[1]	LOS[2]	DDHV	LOS	DDHV	LOS
MA State Line to Exit 1	7,700	F	8,000	F	8,100	E
Exit 1 to Exit 2	5,800	F	6,400	E	6,600	D
Exit 2 to Exit 3	5,500	F	6,100	E	6,100	C
Exit 3 to Exit 4	4,100	E	4,300	C	4,300	B
Exit 4 to Exit 5	4,600	E	4,700	C	4,800	C
North of Exit 5	4,800	F	5,000	D	5,000	C

1 DDHV – Directional Design Hour Volume
2 LOS – Level-of-Service

It is important to recognize that the future design hour volumes represent the volume of traffic during a one-hour period. However, because the peak commuter period currently extends beyond a single hour, the design hour is expected to experience an inflow of volume from the hour before and hour after the design hour as the capacity of the highway is increased with the widening. The principal benefit of the additional capacity will be the shrinking of the nearly 3-hour congestion period that is experienced today by motorists. Also note that as additional lanes are provided on I-93, there is expected to be a modest increase in the ADT and DDHV. This increase in volume reflects the expected diversion of traffic from nearby roadways as capacity is added to I-93.

The 2020 future morning and evening Selected Alternative peak hour volumes at each of the study corridor interchanges and intersections are shown in **Figures 4.2-4 and 4.2-5**. The results of the 2020 Selected Alternative operation analysis for freeway segments and interchanges are summarized in **Figure 4.2-6**.

4.2.4.2 Interchange Operations

In addition to the freeway segment evaluation, level of service analyses were conducted for the ramp and intersection movements at each of the corridor interchanges for a series of different interchange configurations. The ramp and intersection analyses for the various interchange configurations are summarized in Tables 4.2-4 and 4.2-5.

As shown in the tables, all of the ramp movements for the various interchange configurations would operate at an acceptable LOS D or better under the I-93 Four-Lane Alternative. Under the Three-Lane Alternative, the ramp movements at Exits 4 and 5 would continue to show acceptable operation, however ramp movements at Exits 1, 2 and 3 would experience some LOS F levels.

Table 4.2-4
Interchange (Ramp Junction) Analysis Summary - 2020 Build

	Level of Service			
	4-Lane		3-Lane	
Interchange	**AM**	**PM**	**AM**	**PM**
Exit 1				
NB off to CD Rd. (with 2 lane off ramp)	A	B	NA	NA
NB on from CD Rd. to I-93	A	C	NA	NA
NB on ramp	B	C	NA	NA
SB off ramp	C	B	NA	NA
Exit 2 Option: Diamond & Loop				
NB off ramp	B	D	C	F
NB on ramp	A	C	B	F
SB off ramp	D	B	F	C
SB on ramp	B	B	D	C
Exit 3 Options: 1-9				
NB off ramp (with 2 lane off-ramp)	A	C	A	F
NB on ramp	A	C	A	B
SB off ramp	C	B	D	B
SB on ramp (with 2 lane on-ramp)	B	A	F	B
Exit 4 Options: East & West				
NB off ramp (with 2 lane off-ramp)	A	A	A	B
NB on ramp	B	B	B	C
SB off ramp	B	B	C	C
SB on ramp (from E)	B	A	C	B
SB on ramp (from W)	B	B	C	B
Exit 5 Options: Diamond & NB Relocate				
NB off ramp	B	B	B	C
NB on ramp	B	B	B	C
SB off ramp	B	C	C	C
SB on ramp	B	B	C	C

NA = Not applicable. Build Alternatives at Exit 1 only considered with I-93 4-lane cross-section.

Table 4.2-5
Signalized Intersection Analysis Summary – 2020 Build Alternative

Exit 1	Period	Only Option v/c[1]	Delay[2]	LOS[3]
Rockingham Park Boulevard at Mall Entrance	AM Peak	**0.54**	**10.5**	**B**
	PM Peak	**0.63**	**12.6**	**B**

Exit 2	Period	Diamond Alternative v/c	Delay	LOS	Loop Ramp Option v/c	Delay	LOS
Pelham Rd (NH 97) at SB Ramps/Keewaydin Dr.	AM Peak	NA	NA	NA	0.77	29.4	C
	PM Peak	NA	NA	NA	0.85	35.9	D
Pelham Rd (NH 97) at SB Ramps	AM Peak	**0.54**	**14.6**	**B**	NA	NA	NA
	PM Peak	**0.74**	**20.9**	**C**	NA	NA	NA
Pelham Rd (NH 97) at NB Ramp	AM Peak	**0.57**	**19.9**	**B**	0.57	19.9	B
	PM Peak	**0.62**	**19.6**	**B**	0.62	19.6	B
Pelham Rd (NH 97) at Policy St	AM Peak	**0.91**	**26.9**	**C**	0.91	26.9	C
	PM Peak	**0.86**	**29.3**	**C**	0.86	29.3	C
Pelham Rd (NH 97) at Keewaydin Dr.	AM Peak	**0.55**	**6.8**	**A**	NA	NA	NA
	PM Peak	**0.89**	**27.5**	**C**	NA	NA	NA
Pelham Rd (NH 97) at Stiles Rd & Manor Pkwy.	AM Peak	**0.75**	**24.5**	**C**	0.75	24.5	C
	PM Peak	**0.93**	**50.6**	**D**	0.93	50.6	D

Exit 3	Period	Options 1-9 v/c	Delay	LOS
NH 111 at NH 111A	AM Peak	0.69	28.4	C
	PM Peak	0.82	23.4	C

		Options 1,3, 5 v/c	Delay	LOS	Options 2, 4, 6-9 v/c	Delay	LOS
NH 111 at NB Ramps	AM Peak	0.65	13.7	B	**0.71**	**17.6**	**B**
	PM Peak	0.96	31.5	C	**0.95**	**36.0**	**D**

		Options 1-4, 7,8 v/c	Delay	LOS	Options 5, 6, 9 v/c	Delay	LOS
NH 111 at SB Ramps	AM Peak	**0.71**	**19.7**	**B**	0.43	10.7	B
	PM Peak	**0.87**	**13.0**	**B**	0.87	9.0	A

		Options 3-6, 8,9[4] v/c	Delay	LOS
NH 111 at Wall St	AM Peak	**0.75**	**11.5**	**B**
	PM Peak	**0.97**	**29.9**	**C**

Table 4.2-5 (continued)

Exit 4	Period	Only Option v/c	Only Option Delay	Only Option LOS
NH 102 at SB Ramp	AM Peak	**0.55**	**11.7**	**B**
	PM Peak	**0.72**	**17.6**	**B**
NH 102 at SB Ramp (with single SB right)	AM Peak	**0.71**	**15.5**	**B**
	PM Peak	**0.93**	**29.3**	**C**
NH 102 at NB Ramps	AM Peak	**0.71**	**19.4**	**B**
	PM Peak	**0.89**	**34.0**	**C**
NH 102 at Gilcreast Rd	AM Peak	**0.86**	**29.0**	**C**
	PM Peak	**0.99**	**54.6**	**D**
NH 102 at Hampton Dr	AM Peak	**0.71**	**13.0**	**B**
	PM Peak	**0.91**	**26.8**	**C**
NH 102 Fordway Extension	AM Peak	**0.76**	**22.5**	**C**
	PM Peak	**1.17**	**92.8**	**F**

Exit 5	Period	Reconstruct/Relocate NH 28 Option v/c	Reconstruct/Relocate NH 28 Option Delay	Reconstruct/Relocate NH 28 Option LOS	Relocate NB Ramps w/Liberty Dr. Option v/c	Relocate NB Ramps w/Liberty Dr. Option Delay	Relocate NB Ramps w/Liberty Dr. Option LOS
NH 28 at SB Ramps	AM Peak	**0.53**	**22.8**	**C**	0.53	22.8	C
	PM Peak	**0.58**	**23.3**	**C**	0.58	23.3	C
NH 28 at NB Ramps	AM Peak	**0.48**	**17.5**	**B**	0.85	44.4	D
	PM Peak	**0.65**	**18.0**	**B**	0.83	44.3	D

N/A = Not Applicable.
1 Volume to capacity ratio.
2 Average delay per vehicle in seconds.
3 Intersection level of service.
4 Option 1, 2 and 7 do not include a traffic signal at NH 111/Wall Street intersection.
Bold = Selected Alternative.

At Exit 1, each of the ramp movements would operate at LOS C or better (under the 4-lane option) while the nearby signalized Rockingham Park Boulevard/Mall Entrance intersection would operate at LOS B. At Exit 2, both the Diamond and the Loop Ramp options eliminate the existing difficult weave area between the southbound on and off-ramps with all ramp movements under either option operating at LOS D or better. Each of the signalized intersections on Pelham Road would operate at LOS D or better. Note that under the Loop option, the need for a traffic signal at the southbound on-ramp is eliminated.

At Exit 3, each of the ramp movements would operate at LOS D or better (under the 4-lane alternative), while the signalized intersections near the interchange would operate at LOS C or better for all of the nine interchange configuration options. Under the NH 111 on-line option, which would consist of a 3-lane section extending from the interchange westward to the signalized intersection at the

Village Green Plaza, vehicle queues would be expected to back up from the Village Green intersection to the interchange. Left turn movements from the side streets along the 3-lane section would be difficult. In contrast, the NH 111 relocation option, which would provide a 5-lane cross section on a new alignment to the north of existing NH 111 would provide added capacity to accommodate vehicle queuing. The existing section of NH 111 would be converted to a frontage road. The frontage road would connect to NH 111 opposite Wall Street, west of Exit 3, at a new signalized intersection, which would provide safer and more efficient access to NH 111 from the side streets and driveways accessing NH 111 in its current location.

At Exit 4, each of ramp movements would operate at LOS B or better under the 4-lane alternative and LOS C or better under the 3-lane alternative. The nearby signalized intersections would all operate at LOS D or better with the exception of the NH 102/Fordway intersection that would operate at LOS F as it does today and would under the No-Build condition.

At Exit 5, each of the ramp movements would operate at LOS C or better. The signalized NH 28/Southbound Ramp intersection would operate at LOS C, while the NH 28 Northbound Ramp intersection would operate at LOS B. At the intersection of NH 28 and Auburn Road both the left-turn from NH 28 and the right-turn from Auburn Road will operate at a LOS C or better. The northbound ramp intersection, under the option to relocate it opposite Liberty Drive, would operate at LOS D.

For the Selected Alternative, the predicted LOS's will be acceptable from a highway functioning standpoint.

4.2.4.3 Park-and-Ride Facilities

Interchange operations for the 2020 Build Alternative at I-93 Exits 2, 3, and 5 were also evaluated assuming the construction of new park-and-ride facilities. Operational analyses were performed for each interchange assuming full utilization of a 500-space park-and-ride facility supported by bus service. Section 2.3.5.4 provides a description of each park-and-ride lot alternative evaluated and summarizes additional improvements that would be made to the existing roadways to accommodate access to the facilities.

The analysis results indicate that the Exit 2 and Exit 3 interchanges and adjacent signalized intersections would operate at the same level of service with and without a new park-and-ride facility. All intersections would continue to operate at LOS D or better through 2020. No additional improvements would be needed at the interchanges to support the park-and-ride facilities.

Five park-and-ride lot alternatives were evaluated for the Exit 5 interchange. Similar to Exits 2 and 3, the analysis results revealed no substantial change in traffic operations associated with the park-and-ride facility. The intersection of NH 28 and the I-93 southbound ramps would continue to operate at LOS C or better through 2020. The intersection of NH 28 and the northbound ramps would continue to operate at LOS B with the NH 28 on-line option and LOS D with the relocation of the northbound ramps with Liberty Drive. No additional improvements would be needed at the interchange to support the park-and-ride facility.

Operational analyses were also performed at the driveways to each of the park-and-ride facilities for the 2020 Build Alternative at I-93 Exits 2, 3 and 5. The results are summarized in Table 4.2-6. As shown in the table the Exit 2 Park-and-Ride lot driveway at the intersection of South Policy Street and Raymond Avenue would operate at a good level of service (LOS B or better).

Three options were evaluated at Exit 3. Under the Northbound Shift option the park-and-ride driveway, which intersects NH 111 at a signalized T-type intersection, would operate at LOS A. Under the Northbound/Southbound Tight Shift with NH 111A Connector option, the park-and-ride facility would have two access points: a right-in/right-out driveway onto NH 111 and a full access driveway onto NH 111A. NH 111 right-in/right-out driveway would operate at LOS C or better. All movements at the NH 111A driveway would operate good levels of service (LOS B or better) with the exception of the shared left/through movement exiting the park-and-ride facility, which would operate at LOS C in the AM and LOS E in the PM. Under the Northbound/Southbound Tight shift with the NH 111A Relocated option, the park-and-ride facility would have full access onto the relocated NH 111A. The new intersection of NH 111 and NH 111A Relocated would be signalized and operate at a LOS C . The old intersection of NH 111 and NH 111A would be unsignalized with a median prohibiting left-turns from exiting Old NH 111A. All other movements would operate at a LOS B or better. Old NH 111A and NH 111A Relocated would form an unsignalized three-way intersection at which all movements would operate at a LOS C or better.

Six park-and-ride lot alternatives were evaluated at Exit 5. The signalized intersection of Symmes Drive and NH 28 would operate at a good level of service (LOS B) under Option 2 Modified, and would operate at LOS C or better under Options 1, 2, and 3. The signalized intersection of NH 28 and Liberty Drive would operate at LOS C under Option 4 and LOS D under Option 5. The right-turn exiting movement from Auburn Road onto NH 28 would operate at LOS B under Option 4 and LOS C or better under Option 5.

Table 4.2-6
Park-and-Ride Intersection Analysis Summary – 2020 Build Alternatives

Exit 2

Location	Period	v/c[1]	Delay[2]	LOS[3]
South Policy Street /	AM Peak	**0.51**	**8.2**	**A**
Raymond Ave (s)	PM Peak	**0.73**	**18.8**	**B**

Exit 3

		NB Shift			NB / SB Tight Shift – NH 111A Connector			NB / SB Tight Shift w/ NH 111A Relocated		
Location	**Period**	**v/c**	**Delay**	**LOS**	**Demand[4]**	**Delay**	**LOS**	**v/c**	**Delay**	**LOS**
NH Route 111 /	AM Peak	0.56	6.2	A	-	-	-	-	-	-
Park & Ride Driveway (s)	PM Peak	0.65	6.3	A	-	-	-	-	-	-
NH 111 / Park &Ride Drive (u)										
-Right turn out	AM Peak	-	-	-	5	12.0	B	-	-	-
-Right turn out	PM Peak	-	-	-	65	17.0	C	-	-	-
NH 111A / Park & Ride Drive (u)										
-LT from NH 111A NB	AM Peak	-	-	-	5	8.3	A	-	-	-
-LT from NH 111A SB		-	-	-	10	8.6	A	-	-	-
-All from Edgewood		-	-	-	45	13.4	B	-	-	-
-LT/TH from Park & Ride		-	-	-	70	19.4	C	-	-	-
-RT from Park & Ride		-	-	-	0	10.3	B	-	-	-
NH 111A / Park & Ride Drive (u)										
-LT from NH 111A NB	PM Peak	-	-	-	0	8.8	A	-	-	-
-LT from NH 111A SB		-	-	-	40	8.2	A	-	-	-
-All from Edgewood		-	-	-	30	12.1	B	-	-	-
-LT/TH from Park & Ride		-	-	-	165	36.9	E	-	-	-
-RT from Park & Ride		-	-	-	15	13.0	B	-	-	-
NH 111 at	AM Peak	-	-	-	-	-	-	**0.68**	**21.7**	**C**
NH 111A Relocated (s)	PM Peak	-	-	-	-	-	-	**0.78**	**23.3**	**C**
								Demand	**Delay**	**LOS**
NH 111 at Old NH 111A (u)										
-LT from NH 111	AM Peak	-	-	-	-	-	-	**70**	**9.6**	**A**
-RT from Old NH 111A		-	-	-	-	-	-	**165**	**10.1**	**B**
-LT from NH 111	PM Peak	-	-	-	-	-	-	**90**	**11.4**	**B**
-RT from Old NH 111A		-	-	-	-	-	-	**120**	**10.8**	**B**
NH 111A Rel at Old NH 111A (u)										
-LT from NH 111A Rel	AM Peak	-	-	-	-	-	-	**5**	**8.5**	**A**
-All from Old NH 111A		-	-	-	-	-	-	**90**	**16.8**	**C**
-LT from NH 111A Rel.	PM Peak	-	-	-	-	-	-	**20**	**8.1**	**A**
-All from Old NH 111A		-	-	-	-	-	-	**120**	**23.4**	**C**

Table 4.2-6 (continued)

Exit 5		Options 1-2			Option 2 Modified			Option 3		
Location	Period	v/c	Delay	LOS	v/c	Delay	LOS	v/c	Delay	LOS
NH 28 /	AM Peak	0.48	20.4	C	**0.48**	**19.0**	**B**	0.46	18.1	B
Symmes Drive (s)	PM Peak	0.65	27.7	C	**0.55**	**19.0**	**B**	0.68	25.7	C
NH 28/Perkins Road (u)										
LT from NH 28	AM Peak	-	-	-	**0.03**	**9.1**	**A**	-	-	-
RT from Perkins Road		0.11	10.9	B	**0.11**	**10.9**	**B**	0.11	10.9	B
LT from NH 28	PM Peak	-	-	-	**0.26**	**13.1**	**B**	-	-	-
RT from Perkins Road		0.13	13.0	B	**0.13**	**13.0**	**B**	0.13	13.0	B

		Option 4			Option 5		
	Period	v/c	Delay	LOS	v/c	Delay	LOS
NH 28 /	AM Peak	0.65	28.1	C	0.88	41.8	D
Liberty Drive (s)	PM Peak	0.83	34.0	C	0.92	41.2	D
		Demand	Delay	LOS	Demand	Delay	LOS
NH 28 / Auburn Road (u)							
-RT from Auburn Road	AM Peak	475	13.8	B	550	17.9	C
-RT from Auburn Road	PM Peak	280	11.5	B	380	12.1	B

1 Volume to capacity ratio.
2 Average delay per vehicle expressed in seconds.
3 Intersection level of service (approach level of service for unsignalized locations).
4 Volume expressed in vehicles per hour.
(s) Signalized intersection.
(u) Unsignalized intersection.
Bold = Selected Alternative

■

4.2.5 Transportation Systems Management

Transportation Systems Management (TSM) refers to short range, moderately priced measures aimed at reducing congestion and enhancing safety on the existing transportation system or roadway network. As described in Section 2.3.2, a series of geometric upgrades at the interchanges located at Exits 2 through Exit 5 were evaluated. The possible actions include:

- Exit 2 – Extend the northbound on-ramp to provide greater distance for vehicles to enter the highway and for trucks to get up to speed. Upgrade Pelham Road to provide a four-lane cross section in the vicinity of the interchange.

- Exit 3 – Widen the northbound off-ramp to provide double left-turn lanes onto NH 111 westbound. Better delineate and channelize the right-turn movement onto the southbound on-ramp.

- Exit 4 – Extend the left-turn storage lane for the NH 102 eastbound left-turn movement onto the I-93 northbound on-ramp.

- Exit 5 – Lengthen the southbound off-ramp and widen the shoulder area on I-93 approaching the ramp in response to long queue that currently backs onto I-93. Modify the signal timing at the southbound ramp to increase "green time" for the southbound off-ramp approach.

These TSM actions can provide some short-term relief, but would not address the long-term safety and capacity needs of the highway. The capital investment needed to provide these short-term improvements would be better spent on a more permanent transportation solution.

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4.2.6 Transportation Demand Management

Transportation Demand Management (TDM) encompasses a variety of strategies that are designed to change personal travel behavior to reduce the demand for automobile use and the need for highway capacity expansion. TDM measures typically provide means by which commuter (and travelers) can reach destinations utilizing alternatives to the single occupancy of motor vehicles. TDM measures include consideration of infrastructure investments to provide and expand alternative modes of transportation such as HOV lanes, park-and-ride facilities, bicycle facilities, bus services, and rail service.

Section 2.3.4, Transportation Demand Management, and Section 2.3.5, Mode Alternatives, describe various strategies considered. TDM measures that encourage the use of bus transit, employer shuttles, ride matching are currently being employed within the corridor and enhancement of these strategies would to some extent reduce the number of single occupancy vehicles. As described in Section 3.2.8.4, recently the State of NH in a cooperative effort with the State of Massachusetts implemented express bus service for New Hampshire employees working at a bio-pharmaceutical company in Andover, Massachusetts.

Additional cooperative efforts will be evaluated and considered within the corridor to provide similar commuter service between NH park-and-ride facilities and employment centers in Massachusetts. Among the centers to be considered are:

- The River Road TMA in Andover
- The Junction TMO (Transportation Management Organization) serving the Ballardvale Street and Lowell Junction area in Andover and Wilmington
- The Artery Business Committee TMA in Boston
- Commuter Works/MASCO in Boston (Longwood Medical and Academic Area)
- The Interinstitutional TMA in Boston (Boston Medical Center)
- The Logan TMA at Logan Airport
- The Seaport TMA in South Boston
- The Charles River TMA in Cambridge
- The 128 Business Council TMA

New park-and-ride facilities to provide the necessary support for transit services and ultimately help support TDM measures are proposed along I-93 at Exits 2, 3, and 5. The proposed facility at Exit 3 would replace the existing facility west of Exit 3. The existing park-and-ride facility at Exit 4 would continue to provide bus service. Expanded bus service (that is, bus service to Boston from the new park-and-ride facilities) is proposed. See Section 2.3.5.3 for a description of the expanded bus services. By providing these capital investments, it is expected that bus providers will be able to implement the proposed expanded service. The new park-and-ride lots will also facilitate enhanced ride-sharing opportunities to major employers along I-93 in northern Massachusetts.

4.3 Air Quality Impacts

The air quality analysis presents the results of the regional and local air quality evaluation of the I-93 Transportation Corridor Project. The regional evaluation discusses the proposed project's compliance with Transportation Conformity and the local evaluation presents a microscale analysis that evaluates the carbon monoxide (CO) hotspot impacts. Background information on current conditions and attainment status is contained in Section 3.3.

■

4.3.1 Transportation Conformity

The U.S. Department of Transportation (USDOT) and the U.S. Environmental Protection Agency (USEPA) have established conformity procedures to ensure that transportation projects are in compliance with State Implementation Plans (SIPs). Transportation Conformity requires that the proposed transportation projects be part of an MPO adopted Transportation Improvement Program (TIP) for urbanized areas and the total estimated emissions of all projects should meet the air quality budgets established in the SIPs. The Selected Alternative for the I-93 Salem to Manchester project, widening I-93 to 8 lanes (4 lanes in each direction), was included in the NHDOT's Statewide Transportation Improvement Program (STIP) for Fiscal Years 2003-2005, the MPO Long-Range Plans for 2003-2022, and were also included in the "Fiscal Year 2003 Conformity Determination." The STIP, which includes this project, was approved by FHWA and FTA in November 2002 as satisfying the transportation conformity requirements. Since the regional air quality impacts of the I-93 Salem to Manchester Transportation Corridor Project were addressed in the transportation conformity analysis, pursuant to 23 CFR 770, this project conforms to the SIP and no additional analysis of regional emissions is required, and none have been included in this air quality study.

NHDOT evaluated the air quality impacts of widening I-93 from Salem to Manchester to 3 lanes in each direction and with 4 lanes in each direction for the Ozone analysis

years of 2012 and 2022. This analysis was based on the regional transportation model runs by the Southern New Hampshire Planning Commission and the Rockingham Planning Commission.

It is anticipated that the total air quality emissions (VOC and NOx in kgs/day) for the I-93 Salem to Manchester widening project under either of the scenarios (3 lanes in each direction or 4 lanes in each direction), along with the air quality emissions from other transportation projects in the region will be within the air quality emission budgets for the analysis years of 2012 and 2022, and would meet the Conformity requirements for the Southern NH Serious non-attainment area.

The air quality study includes a microscale modeling analysis that predicts CO levels at critical receptor locations along the project corridor. The microscale analysis was conducted according to USEPA guidelines. The results of the air quality analysis demonstrate that the proposed project will not interfere with the attainment or maintenance of the National Ambient Air Quality Standards (NAAQS) for CO. These results are consistent with the study area's designation as attainment for CO.

■

4.3.2 Alternatives

Chapter 2 presents a discussion of the evaluation of alternatives that were considered and presents the alternatives that were recommended for further evaluation. The air quality study (see Section 3.3) ranked all of the intersections from the alternatives that were selected for further evaluation based upon total traffic volumes and levels of service. The three intersections with the highest traffic volumes and the three intersections with the worst levels of service, regardless of which alternative they came from, were selected for evaluation. The air quality analysis also included four intersections in the Manchester CO Maintenance area. In addition, the air quality study evaluated the right-of-way area (i.e., "open space") along the segment of I-93 with the highest traffic volumes. These intersections are listed in Section 3.3.2.2. Microscale Analysis. The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

The air quality analysis represents a worst-case condition because it used the traffic data from the 4-lane alternative. The CO results would be lower if the traffic data from the 3-lane alternative was used. The air quality analysis demonstrates that both the 4-lane and 3-lane alternatives would meet the NAAQS.

■

4.3.3 Project Impacts

The microscale analysis was conducted to determine whether the proposed project complies with the 1990 Clean Air Act Amendments (CAAA) and SIP criteria. Tables 4.3-1 and 4.3-2 present the maximum predicted 1-hour and 8-hour CO

Table 4.3-1
Predicted Maximum 1 Hour CO Concentrations (Parts Per Million)[1]

Receptor No. and Location[2, 4]	1997 Existing	2010 No-Build	2010 4-Lane[3] Build	2020 No-Build	2020 4-Lane[3] Build
Fordway Extension and NH 102					
1. 80 West Broadway	4.8	3.7	3.7	3.9	3.9
2. 55 West Broadway	8.3	4.9	4.8	4.8	4.7
3. 49 West Broadway	6.8	4.3	4.2	4.2	4.2
4. 78 West Broadway	4.8	3.7	3.7	3.8	3.9
I-93 Exit 3 Northbound Ramp and NH 111					
5. Open Space Southwest Quadrant	9.4	7.0	7.1	8.0	8.1
6. 123/125 Indian Rock Road	10.1	7.4	7.8	8.0	8.3
7. Open Space/Country Corner Store	10.2	7.5	7.7	8.0	8.4
I-93 Exit 2 Southbound Ramp, Pelham Road, and Keewaydin Drive					
8. 25 Pelham Road	10.5	7.8	6.6	8.0	7.3
9. Open Space Northwest Quadrant	9.0	6.9	6.6	7.5	7.2
10. Open Space Southeast Quadrant	10.1	7.3	9.3	9.1	9.7
11. Open Space Northeast Quadrant	8.3	6.3	6.1	7.2	6.7
I-93 Exit 2 Northbound Ramp and Pelham Road					
12. Open Space Northwest Quadrant	10.3	7.6	6.7	8.1	7.3
13. Open Space Southwest Quadrant	10.6	8.4	6.9	8.9	7.6
14. Open Space Southeast Quadrant	10.0	7.5	6.6	8.2	7.1
15. Open Space Northeast Quadrant	10.7	8.0	6.9	8.9	8.0
I-93 Right-of-Way					
16. Open Space	4.2	3.7	3.7	3.9	3.7
Route 28A at Huse Road[5]					
17. Southwest Corner (Dentist Office)	11.5	8.4	8.4	8.6	8.6
18. East (Easter Seal Society)	12.0	9.0	8.9	10.2	10.4
19. Northwest Corner (7 Mammoth Road)	10.0	7.7	7.7	8.1	8.2
Route 28A at Cilley Road[5]					
20. East (Robert School)	10.5	8.0	8.1	8.5	8.9
21. Northwest Corner (Convenience Store)	12.0	8.9	8.9	9.5	9.5
22. Southwest Corner	11.8	8.9	8.9	9.2	9.2
Route 28A at Candia Road[5]					
23. Southwest Quadrant (Stills Power Equipment)	10.0	8.3	8.3	8.7	9.0
24. Southeast Quadrant (181 Mammoth Road)	11.6	8.8	8.8	10.1	10.5
25. Northeast Quadrant (193 Mammoth Road)	12.0	9.1	9.1	9.9	10.2
26. Northwest Quadrant (Hess)	10.9	8.6	8.7	9.7	9.9
Route 28A at Massabesic Road[5]					
27. Southeast Quadrant (203 Mammoth Road)	10.2	8.4	8.4	9.1	9.3
28. Northeast Quadrant	9.3	7.8	7.8	8.3	8.7
29. Northwest Quadrant	10.6	8.9	8.9	10.3	10.6
30. Southwest Quadrant (Hess)	11.1	9.1	9.1	9.8	10.0

Source: Vanasse Hangen Brustlin, Inc.

1 The concentrations are expressed in parts per million (ppm) and include a 1-hour background concentration of 2.0 ppm. The 1-hour NAAQS for CO is 35 ppm.

2 The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

3 The air quality analysis was based upon traffic data from the 4-Lane Alternative. The CO results would be lower for the 3-Lane Alternative.

4 See **Figure 3.3-1** for locations.

5 These intersections were analyzed subsequent to the DEIS.

Table 4.3-2
Predicted Maximum 8 Hour CO Concentrations (Parts Per Million)[1]

Receptor No. and Location[2,4]	1997 Existing	2010 No-Build	2010 4 Lane[3] Build	2020 No-Build	2020 4 Lane[3] Build
Fordway Extension and NH Route 102					
1. 80 West Broadway	4.0	3.2	3.2	3.3	3.3
2. 55 West Broadway	6.4	4.0	4.0	4.0	3.9
3. 49 West Broadway	5.4	3.6	3.5	3.5	3.5
4. 78 West Broadway	4.0	3.2	3.2	3.3	3.3
I-93 Exit 3 Northbound Ramp and NH Route 111					
5. Open Space Southwest Quadrant	7.2	5.5	5.6	6.2	6.3
6. 123/125 Indian Rock Road	7.7	5.8	6.1	6.2	6.4
7. Open Space/Country Corner Store	7.7	5.9	6.0	6.2	6.5
I-93 Exit 2 Southbound Ramp, Pelham Road, and Keewaydin Drive					
8. 25 Pelham Road	8.0	6.1	5.2	6.2	5.7
9. Open Space Northwest Quadrant	6.9	5.4	5.2	5.9	5.6
10. Open Space Southeast Quadrant	7.7	5.7	7.1	7.0	7.4
11. Open Space Northeast Quadrant	6.4	5.0	4.9	5.6	5.3
I-93 Exit 2 Northbound Ramp and Pelham Road					
12. Open Space Northwest Quadrant	7.8	5.9	5.3	6.3	5.7
13. Open Space Southwest Quadrant	8.0	6.5	5.4	6.8	5.9
14. Open Space Southeast Quadrant	7.6	5.9	5.2	6.3	5.6
15. Open Space Northeast Quadrant	8.1	6.2	5.4	6.8	6.2
I-93 Right-of-Way					
16. Open Space	3.5	3.2	3.2	3.3	3.2
Route 28A at Huse Road[5]					
17. Southwest Corner (Dentist Office)	8.1	5.9	5.9	6.0	6.0
18. East (Easter Seal Society)	8.4	6.3	6.2	7.1	7.3
19. Northwest Corner (7 Mammoth Road)	7.0	5.4	5.4	5.7	5.7
Route 28A at Cilley Road[5]					
20. East (Robert School)	7.4	5.6	5.7	6.0	6.2
21. Northwest Corner (Convenience Store)	8.4	6.2	6.2	6.7	6.7
22. Southwest Corner	8.3	6.2	6.2	6.4	6.4
Route 28A at Candia Road[5]					
23. Southwest Quadrant (Stills Power Equipment)	7.0	5.8	5.8	6.1	6.3
24. Southeast Quadrant (181 Mammoth Road)	8.1	6.2	6.2	7.1	7.4
25. Northeast Quadrant (193 Mammoth Road)	8.4	6.4	6.4	6.9	7.1
26. Northwest Quadrant (Hess)	7.6	6.0	6.1	6.8	6.9
Route 28A at Massabesic Road[5]					
27. Southeast Quadrant (203 Mammoth Road)	7.1	5.9	5.9	6.4	6.5
28. Northeast Quadrant	6.5	5.5	5.5	5.8	6.1
29. Northwest Quadrant	7.4	6.2	6.2	7.2	7.4
30. Southwest Quadrant (Hess)	7.8	6.4	6.4	6.9	7.0

Source: Vanasse Hangen Brustlin, Inc.

1 The concentrations are expressed in parts per million (ppm) and include an 8-hour background concentration of 2.0 ppm. The 8-hour NAAQS for CO is 9 ppm.

2 The air quality study assumes that if these intersections meet the NAAQS, then all other intersections, regardless of alternative, which will have lower volumes and better levels of service, can be assumed to also meet the NAAQS.

3 The air quality analysis was based upon traffic data from the 4-Lane Alternative. The CO results would be lower for the 3-Lane Alternative.

4 See Figure 3.3-1 for locations.

5 These intersections were analyzed subsequent to the DEIS.

concentrations, respectively, for the 1997 Existing, 2010 No-Build, 2010 Build, 2020 No-Build, and 2020 Build conditions. The tables include those receptor locations that exhibited the highest CO concentrations for each quadrant of each intersection.

The results of the microscale analysis show that, under all future conditions (2010 and 2020 No-Build and Build), predicted CO concentrations at all receptor locations are below predicted concentrations for 1997 Existing Conditions. These reductions in CO concentrations can be attributed to more efficient vehicles with enhanced emissions control technologies as mandated by the Federal Motor Vehicle Exhaust Emissions Control Program for new vehicles entering the fleet. The results of the microscale analysis also demonstrate that the proposed project satisfies the SIP criteria for CO because all the 1997, 2010, and 2020 No-Build and Build CO concentrations (both 1 hour and 8 hour values) are below the NAAQS of 35 and 9 ppm, respectively. The results for each intersection and the I-93 right-of-way analyzed are discussed below.

Fordway Extension and NH 102

The maximum 1-hour CO concentrations modeled for the existing (1997) condition range from 4.8 to 8.3 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 4.0 ppm near 80 West Broadway to a maximum of 6.4 ppm near 55 West Broadway.

Under the No-Build Alternative, the maximum modeled 1-hour CO concentrations in 2010 range from 3.7 to 4.9 ppm, and in 2020, from 3.8 to 4.8 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 3.2 ppm to a maximum of 4.0 ppm in 2010 and a range of 3.3 to 4.0 ppm in 2020.

The maximum 2010 1-hour Build Alternative concentrations are modeled to range from 3.7 to 4.8 ppm and from 3.9 to 4.7 ppm in 2020 for the Build Alternative. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 3.2 ppm to a maximum of 4.0 ppm in 2010 and a range of 3.3 to 3.9 ppm in 2020. A comparison with the No-Build Alternative indicates that construction of the I-93 project will result in very little change in modeled concentrations for the modeled receptor location at this intersection.

I-93 Exit 3 Northbound Ramp at NH 111

The maximum 1-hour CO concentrations modeled for the existing (1997) condition range from 9.4 to 10.2 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 7.2 ppm near the southwest quadrant of the intersection to a maximum of 7.7 ppm located near the country store corner.

Under the No-Build Alternative, the maximum modeled 1-hour CO concentrations in 2010 range from 7.0 to 7.5 ppm, and in 2020, were 8.0 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.5 ppm to a maximum of 5.9 ppm in 2010 and to 6.2 ppm in 2020.

The maximum 2010 1-hour Build Alternative concentrations are modeled to range from 7.1 to 7.8 ppm and from 8.1 to 8.4 ppm in 2020 for the Build Alternative. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.6 ppm to a maximum of 6.1 ppm in 2010 and a range of 6.3 to 6.5 ppm in 2020. A comparison with the No-Build Alternative indicates that construction of the I-93 project will result in slightly higher modeled concentrations for the modeled receptor locations at this intersection.

I-93 Exit 2 Southbound Ramp, Pelham Road and Keewaydin Drive

The maximum 1-hour CO concentrations modeled for the existing (1997) condition range from 8.3 to 10.5 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 6.4 ppm near the northeast quadrant of the intersection to a maximum of 8.0 ppm near 25 Pelham Road.

Under the No-Build Alternative, the maximum modeled 1-hour CO concentrations in 2010 range from 6.3 to 7.8 ppm, and in 2020, from 7.2 to 9.1 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.0 ppm to a maximum of 6.1 ppm in 2010 and a range of 5.6 to 7.0 ppm in 2020.

The maximum 2010 1-hour Build Alternative concentrations are modeled to range from 6.1 to 9.3 ppm and from 6.7 to 9.7 ppm in 2020 for the Build Alternative. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 4.9 ppm to a maximum of 7.1 ppm in 2010 and a range of 5.3 to 7.4 ppm in 2020. Construction of the I-93 project would result in slightly higher modeled concentrations at one of the modeled receptor locations. The remaining receptor locations at this intersection will experience small reductions.

I-93 Exit 2 Northbound Ramp and Pelham Road

The maximum 1-hour CO concentrations modeled for the existing (1997) condition range from 10.0 to 10.7 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 7.6 ppm near the southeast quadrant to a maximum of 8.1 ppm near the northeast quadrant of the intersection.

Under the No-Build Alternative, the maximum modeled 1-hour CO concentrations in 2010 range from 7.5 to 8.4 ppm, and in 2020, 8.1 to 8.9 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.9 ppm to a maximum of 6.5 ppm in 2010 and ranged from 6.3 to 6.8 ppm in 2020.

The maximum 1-hour CO 2010 Build Alternative concentrations are modeled to range from 6.6 to 6.9 ppm in 2010 and from 7.1 to 8.0 ppm in 2020 for the Build Alternative. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.2 ppm to a maximum of 5.4 ppm in 2010 and ranged from 5.6 to 6.2 ppm in 2020. Construction of the I-93 project would result in similar or slightly

lower modeled concentrations for the modeled receptor locations at this intersection.

I-93 Right-of-Way

A single receptor location representing the highway right-of-way south of Exit 1 was evaluated to represent the worse case CO concentrations along I-93, as the highest traffic exists and are projected to occur at this location. The receptor was located 70 feet (21 meters) from the nearest travel lane. The maximum 1-hour CO concentration modeled for the existing (1997) condition was 4.2 ppm. The corresponding maximum 8-hour CO concentration was 3.5ppm. Under the No-Build Alternative, the maximum modeled 1-hour CO concentration in 2010 was 3.7 ppm, and in 2020, 3.9 ppm. The corresponding maximum 8-hour CO concentration was 3.2 ppm in 2010 to 3.3 ppm in 2020.

The maximum 1-hour CO 2010 Build Alternative concentration is 3.7 ppm for both 2010 and 2020. The corresponding maximum 8-hour CO concentration was 3.2 ppm. Construction of the I-93 project would result in similar CO concentrations to the No-Build concentrations along the I-93 right-of-way.

Route 28A at Huse Road

The maximum 1–hour CO concentrations modeled for the existing (1997) condition range from a minimum of 10.0 ppm to a maximum of 12.0 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 7.0 ppm in the northwest corner to a maximum of 8.4 ppm to the east near the Easter Seal Society.

Under the No Build Alternative the maximum modeled 1–hour CO concentrations in 2010 range from 7.7 ppm to a maximum of 9.0 ppm and in 2020, 8.1 to 10.2 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.4 ppm to a maximum of 6.3 ppm in 2010 and ranged from 5.7 to 7.1 ppm in 2020.

The maximum 1–hour CO 2010 Build Alternative concentration are modeled to range from a minimum of 7.7 ppm to a maximum of 8.9 ppm and ranged from 8.2 to 10.4 ppm in 2020. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.4 to a maximum of 6.2 ppm in 2010 and from 5.7 to 7.3 ppm in 2020.

Route 28A at Cilley Road

The maximum 1–hour CO concentrations modeled for the existing (1997) condition range from a minimum of 10.5 ppm to a maximum of 12.0 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 7.4 ppm near the Robert School to a maximum of 8.4 ppm near the convenience store.

Under the No Build Alternative the maximum modeled 1–hour CO concentrations in 2010 range from a minimum of 8.0 ppm to a maximum of 8.9 ppm and in 2020, 8.5 to 9.2 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.6 ppm to a maximum of 6.2 ppm in 2010 and ranged from 6.0 to 6.7 ppm in 2020.

The maximum 1–hour CO 2010 Build Alternative concentration are modeled to range from a minimum of 8.1 ppm to a maximum of 8.9 ppm and ranged from 8.9 to 9.5 ppm in 2020. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.7 ppm to a maximum of 6.2 ppm in 2010 and ranged from 6.2 to 6.7 ppm in 2020.

Route 28A at Candia Road

The maximum 1–hour CO concentrations modeled for the existing (1997) condition range from a minimum of 10.0 ppm to a maximum of 12.0 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 7.0 ppm near Stills Power Equipment to a maximum of 8.4 ppm near 193 Mammoth Road or the northwest corner of the intersection.

Under the No Build Alternative the maximum modeled 1–hour CO concentrations in 2010 range from a minimum of 8.3 ppm to a maximum of 9.1 ppm and in 2020, ranged from 8.7 to 10.1ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.8 ppm to a maximum of 6.4 ppm in 2010 and ranged from 6.1 to 7.1 ppm in 2020.

The maximum 1–hour CO 2010 Build Alternative concentration are modeled to range from a minimum of 8.3 ppm to a maximum of 9.1 ppm and range from 9.0 to 10.5 ppm in 2020. The corresponding maximum 8-hour CO concentrations ranged from 5.8 to 6.4 ppm in 2010 and 6.3 to 7.4 ppm in 2020.

Route 28A at Massabesic Road

The maximum 1–hour CO concentrations modeled for the existing (1997) condition range from a minimum of 9.3 ppm to a maximum of 11.1 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 6.5 ppm near the northeast quadrant of the intersection to 7.8 ppm near the Hess gas station at the southwest quadrant.

Under the No Build Alternative the maximum modeled 1–hour CO concentrations in 2010 range from 7.8 to 9.1 ppm and in 2020, 8.3 to 10.3 ppm. The corresponding maximum 8-hour CO concentrations ranged from a minimum of 5.5 ppm to a maximum of 6.4 ppm in 2010 and ranged from 5.8 to 7.2 ppm in 2020.

The maximum 1–hour CO 2010 Build Alternative concentration are modeled to range from 7.8 to 9.1 ppm and from 8.7 to 10.6 ppm in 2020. The corresponding

maximum 8-hour CO concentrations ranged from a minimum of 5.5 to 6.4 ppm in 2010 and ranged from 6.1 to 7.4 ppm in 2020.

The results of the air quality study demonstrated the maximum 1-hour concentrations for each intersection were below the NAAQS of 35 ppm for all conditions analyzed (See Table 4.3-1). The maximum modeled 8-hour CO concentrations for each intersection are presented in Table 4.3-2. All of the maximum 8-hour CO concentrations are also well below the 8-hour NAAQS of 9 ppm.

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4.3.4 Secondary Impacts

The air quality analysis calculated emissions for the existing, estimated year of project completion, and design year. These emission estimates are based upon the traffic projections developed for the proposed project and its alternatives, which are discussed in Section 4.2. The impacts associated with potential secondary growth for air quality, such as industrial sources, and future residential and commercial growth cannot be reasonably estimated because of the uncertainty of the size, type, and location of such future development. Traffic growth changes are accounted for in the regional traffic model. Expected land use, traffic growth, and transportation projects are typically considered in future emission estimates for the New Hampshire State Implementation Plan and conformity determinations.

■

4.3.5 Construction Impacts

The proposed I-93 project may result in a temporary increase of air emissions during construction. Emissions from the operation of construction equipment will include nitrogen oxides, sulfur oxides, carbon monoxide, and particulate matter. These emissions will be temporary and the locations at which they occur will be changing over time.

The NHDOT will require the contractors, involved with the reconstruction of I-93, to include air pollution control devices on heavy diesel construction equipment in accordance with applicable state and federal laws at the time of construction. The merits and practicality of more stringent or voluntary specification measures will be considered through the final design process and in consultation with the contracting community and NHDES.

Mitigating fugitive dust emissions involves minimizing or eliminating its generation. Mitigation measures that will be used for construction include wetting and stabilization to suppress dust generation, cleaning paved roadways, and scheduling construction to minimize the amount and duration of exposed earth.

■

4.3.6 Park-and-Ride Facilities

This project includes the establishment or maintenance of park-and-ride facilities to support carpool and transit services. Currently, there are two existing park-and-ride facilities, one west of Exit 3, and one at Exit 4. New facilities are proposed at Exits 2 and 5, along with relocation of the Exit 3 facility closer to the interchange. While the air quality analysis did not quantify the emission reductions from the use of the new and expanded park-and-ride facilities, their implementation will result in some additional improvements to air quality in the study area by promoting alternative forms of transportation that will reduce the number of single occupant vehicles using I-93. Based on ridership projections, approximately 1,800 passenger trips per day are anticipated, which would correlate to up to 900 single occupancy vehicles removed from I-93.

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4.3.7 Conclusion

The air quality analysis demonstrates that this project is in compliance with the 1990 Clean Air Act Amendments and the New Hampshire State Implementation Plan. The results of the microscale analysis demonstrate that the proposed project will not create CO violations in locations, where violations do not currently exist. In fact, the results demonstrate that no CO violations currently exist in the air quality study area. The microscale analysis also demonstrates that CO concentrations for the No-Build and Build Alternatives are all modeled to be below the NAAQS standards for CO.

This project and the Selected Alternative of widening I-93 to 8 lanes, 4 lanes in each direction, also satisfies the transportation conformity requirements because it was evaluated as a proposed improvement in the NHDOT's State Transportation Improvement Program (STIP) for Fiscal Years 2003-2005, which was reviewed by USEPA and found to conform by the U.S. Department of Transportation, as documented in the Fiscal Year 2003-2005 conformity determination dated November 2002.

In summary, the results of the air quality analysis demonstrate that the proposed project is in conformance with the SIP because:

- No new violation of the NAAQS will be created,
- No increase in the frequency or severity of any existing violations will occur, and
- No delay in attainment of any NAAQS standards will result.

4.4 Water Resources Impacts

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4.4.1 Surface Water

4.4.1.1 Introduction

This section presents an analysis of potential impacts to the surface water resources within the study area associated with the proposed project alternatives. The principal project alternatives include the No-Build Alternative which serves as a baseline condition for comparison with other alternatives that include three mainline Build Alternatives. The three Build Alternatives propose adding lanes to I-93, and include two alternatives, which widen I-93 to either three or four lanes in each direction for the entire length of the corridor (i.e., Three-Lane and Four-Lane Alternatives), or a third Combination Alternative that widens I-93 to four lanes through the Exit 3- Interchange area and three lanes north of Exit 3. The impact analyses focused primarily on the Four-Lane Alternative as it represents the worst-case scenario. In addition to widening I-93, each of the five interchanges in the project area will be reconstructed to improve traffic flow and address safety concerns. Each interchange generally has various design alternatives that typically involve only minor differences in ramp alignments and local roadway configurations. The Exit 3 Interchange in Windham, however, has nine (9) different design options including a partial relocation of NH 111 and a "tight-shift" option (Selected Alternative) that would shift the I-93 northbound and southbound lanes to narrow the existing median area through the interchange area. The proposed park-and-ride facilities at Exits 2, 3 and 5 are also included in the Build Alternatives.

The analysis of potential surface water impacts has three separate components. One component focuses on highway runoff and involves estimating the net change in the theoretical pollutant load for each stream under the No-Build and Build Alternatives based on the potential increase in roadway area and the expected treatment effects of the various water quality treatment measures being proposed under the Build Alternatives. The theoretical pollutant load is based on the expected increase in roadway area in each watershed. The potential treatment effects are based on typical removal efficiencies, where runoff from both the existing and new roadway area would be treated. A relative comparison of the amount of I-93 pavement area within each of the watersheds of the streams and rivers under the No-Build and proposed Build Alternatives is also provided. The comparison is used to identify the resources that may be most susceptible to water quality impacts, due to the anticipated increases in pavement area, and related highway runoff as measured by the percentage of I-93 roadway area within the watershed area.

The second component of the impact analysis includes an evaluation of the potential changes in phosphorus loading to the principal lakes in the study area, as a result of the increased roadway area and related runoff discharges. Phosphorus has been found to be contained in highway runoff and can be a principal concern for downstream lakes. Phosphorus is generally the limiting nutrient for plant and algae growth in New Hampshire waters. Increased inputs of phosphorus to lakes can stimulate and promote algal growth, which can lead to nuisance conditions that can interfere with the recreational use of the lake as well as a decline in water quality conditions. As algal growth increases, water clarity decreases, which reduces the sunlight penetration to the bottom layers and affects the aquatic life communities and certain beneficial plant species. Each year as algal cells die off, the organic matter sinks to the bottom and consumes oxygen as part of the decomposition process. As this cycle progresses, lakes continue to have increasing algal growth and tend to have little to no oxygen in the bottom layers for extended periods of the year. Highly productive lakes, with an abundance of aquatic weed and algal growth are generally referred to as being "eutrophic", while lakes having minimal algal productivity and excellent water clarity are classified to be "oligotrophic". Lakes that are moderately productive are classified as being "mesotrophic."

The third component of the impact analysis involves estimating the potential changes in the long-term sodium and chloride concentrations in each of the streams and rivers as a result of the increased deicing applications needed to maintain the added travel lanes. Both the USEPA and NHDES have established a secondary drinking water standard of 250 mg/l for both sodium and chloride (ENV-WS 319.01: State Water Quality Standards) to avoid aesthetic problems associated with taste. NHDES has also established aquatic life criteria for chloride in fresh water resources to protect aquatic life from the possible adverse effects related to osmotic pressure imbalances (i.e., disruption of molecular exchanges through cell membranes) in high saline waters (Env-Ws 1700). The chronic and acute criteria for chloride have been set at 230 and 860 mg/l, respectively, to protect aquatic life. A mass balance analysis was conducted to estimate the average annual in-stream chloride concentrations based on the proposed number of travel lanes in each watershed, an average annual application rate for road salt and an estimated average stream flow rate during the winter months. Background or upstream chloride concentration data collected during the 2002-2003 winter season was incorporated into the analysis.

The following sections describe in greater detail the methods, assumptions and the results of each the separate components of the impact analysis.

4.4.1.2 Impact Analysis Methodology

Highway Runoff

As presented in Section 3.4, there are twenty-one (21) different streams and rivers that are located within or immediately adjacent to the study area that extends over roughly 20.0 miles from Massachusetts to the City of Manchester. These streams range in size from very small tributaries that have watershed areas of less than 150 acres with flow paths of less than a 0.5 mile and are likely to only support seasonal intermittent flow to several larger streams with watershed areas of more than 5,000 acres that flow for many miles and have substantial year-round flow. The larger streams include the Spicket River, the Cohas Brook and Beaver Brook. There are also six lakes or ponds that are located within or downstream of the I-93 roadway corridor and receive flow from one of the tributary streams. The most important lakes include Canobie Lake and Cobbetts Pond, which are discussed further below. Crystal Lake, located in Manchester, is another important lake used extensively for recreation purposes, however, the relatively small section of the I-93 roadway (i.e., approximately 1,800 feet of the southbound lanes) that is within in its watershed has already been partially widened as part of previous bridge replacement work.

There are several small ponds that are less than 10 acres in size and, although they are not on the list of public water bodies maintained by the NHDES, they are still considered surface waters of the state and will be equally protected using the various treatment measures. All of these water resources are currently affected to some degree by the existing I-93 roadway since they receive varying amounts of highway runoff during storm events. The proposed project is not expected to affect any new or additional water bodies that are not currently affected.

Previous research sponsored by the Federal Highway Administration (FHWA) has shown that highway runoff can contain various contaminants and if available in excessive amounts and left untreated, these contaminants can cause deleterious effects on aquatic life in receiving waters (Dupuis et al, 1985). The primary sources of these contaminants include both atmospheric deposition and those derived from vehicular traffic associated with vehicle exhaust and the wear and tear of moving parts such as tires and brake linings. Other potential sources include potential hazardous spills related to vehicle accidents, the possible use of fertilizers along the right-of way and the components of deicing materials, mostly sodium and chloride, which are applied during the winter months to maintain safe travel conditions.

Certain trace metals such as copper and zinc are common components of highway runoff and are linked to the wear and tear of brake linings and the tire rubber, respectively (Dupuis et al., 1985). Studies have found that the accumulation of copper and zinc on pavement tends to increase with increasing traffic volumes. Some of the older FHWA studies have also indicated that lead was once prevalent in highway runoff due to the lead content in leaded gasoline. However, since the

introduction of unleaded gasoline more than 25 years ago, lead is no longer a major concern as it relates to highway runoff. Other runoff constituents, such as phosphorus and nitrogen, are primarily derived from atmospheric deposition on the pavement. An increase in pavement area will generally result in an increase in pollutant load primarily because of the increase in runoff volume but also due to the increased impervious area allows for more pollutants to accumulate and be washed off later in the next storm event.

Several predictive models have been developed over the years to try predict the amount of highway-related pollutants that may be generated from a given roadway area based on several related factors such as traffic levels, pavement area, drainage infrastructure and surrounding land use conditions (Driscoll et al. 1990). However, these models have had limited success in accurately predicting the potential pollutant load and the resulting in-stream concentration under highly variable, site-specific factors (Coleman et. al., 2001). The primary problem is that there is no scientific or mathematical procedure to extrapolate sampling data from one location or region to accurately reflect pollutant accumulation and loading conditions at another highway location under a completely different set of site-specific factors. The model user must arbitrarily select or determine an appropriate initial pollutant concentration and then a potential future concentration that best represents both the existing and future conditions related to traffic levels, drainage infrastructure, atmospheric deposition and other site-specific factors. In addition, pollutant contributions from other sources in the watershed must be accounted for to develop a final in-stream concentration. This determination is extremely difficult to do with any reasonable accuracy and typically produces results with a large margin of error that may not be anywhere close to reality.

The following analysis involves a different approach. Rather than rely on the predictive models, the analysis conservatively assumes that the future pollutant load to each stream under the proposed Four-Lane Alternative will double or increase by 100 percent relative to the No-Build Alternative. This more than adequately accounts for any potential increases in highway runoff constituents related to the increased roadway area that may be derived from atmospheric deposition, primarily nitrogen and phosphorus. This assumption, however, is likely to grossly overestimate the potential increases in the vehicle-derived pollutants (i.e., copper, zinc, oil and grease, etc.) relative to the No-Build Alternative, since future traffic levels are expected to be essentially the same with either the Build or No-Build Alternatives. In fact, it could be reasonably argued that the future quantities of vehicle-related pollutant could be much higher with the No-Build Alternative, since traffic congestion is expected to occur for longer periods and on longer sections of the roadway. Traffic congestion causes more wear and tear of moving parts, particularly brakes and tires, and allows vehicles to drip fluids or discharge vehicle exhaust for longer periods in the same roadway area. Traffic congestion also generally causes more accidents, which may lead to inadvertent leaks and spills of vehicle fluids and perhaps hazardous materials transported as cargo. The No-Build Alternative does not provide for any initial

containment of hazardous spills, whereas the Selected Alternative will, through the extensive use of detention basins and treatment swales.

In addition, in review of the various highway runoff data collected at various locations across the country and compiled by the FHWA, the difference between the median pollutant concentrations (i.e., 50 percent of the sites) and those observed at the high end of the range (i.e., 90 percent of the sites) for urban highways is much less than 100 percent for most parameters (Driscoll et. al., 1990). This further supports the assertion that a 100 percent increase in pollutant contributions used in this analysis represents a worst-case analysis. The second step in the analysis involves factoring in the expected treatment effects associated with the proposed water quality treatment measures (i.e., extended-detention basins and grassed swales) that have been included into the preliminary design plans of the proposed Build Alternatives. Thus, the net change in pollutant load can be determined based on the anticipated amount of increased roadway area, the amount of roadway area that will be directed to a treatment device and the anticipated treatment efficiency of the selected device.

In expressing the analysis mathematically if the existing pollutant contribution to the area streams is represented by X, then the future contribution would then be 2(X) or twice the existing load to account for the 100 percent increase in roadway area in each of the watersheds. Furthermore, if under the proposed Build Alternatives, runoff from the entire roadway, including both the existing and the newly created portions, is directed to properly designed extended-detention basins, and, assuming an average removal efficiency of 60 percent, then the resulting pollutant load would be (2X)(1-0.6) or (2X - 1.2X) or 0.8X, or 20 percent less than the anticipated pollutant contributions under the No-Build Alternative. Previous studies have found that detaining storm water for 24 hours or more can remove as much as 90 percent of the total suspended solids (TSS) and as much as 60 percent of the available nutrients and trace metals contained in runoff (NHDES 1996).

The key aspect of this approach relies on providing adequate water quality treatment along the entire project corridor, using the best available technology to treat and enhance runoff quality. If extended-detention basins and grassed swales can be provided in enough locations to treat runoff from nearly the entire roadway, including both existing and new roadway area, then the proposed project could result in a net benefit to the area water resources. In other words, in order to achieve a no net increase in pollutant contributions in comparison to the No-Build Alternative, a minimum of 80 percent of the total roadway area in each watershed would have to be directed toward extended detention basins, assuming an overall removal efficiency of 60 percent. If more than 80 percent of the total roadway is treated by extended-detention basins, this could result in a net reduction in the existing pollutant loading. If a lower removal efficiency of 40 percent was assumed, then this would result in a net 20 percent increase over the existing load, again, assuming that the future pollutant load in highway runoff

will increase by 100 percent with the proposed project in comparison to the No-Build Alternative. For reasons described earlier, it is highly unlikely that the future pollutant load associated with highway runoff will be twice, or 100 percent higher than that under the No-Build Alternative given the added accumulation that will occur with increased traffic congestion and accident potential in future years with the No-Build Alternative.

To estimate the amount of new right-of-way area that would be required for each extended-detention basin, it was assumed that each basin would need sufficient storage to detain and prolong the release of the "first-flush" volume (i.e., ½ inch of runoff over all impervious area) for approximately 30 hours and have a minimum length to width ratio of 4 to 1. This design is intended to maximize the removal efficiency and exceeds the NHDES design guidance, which recommends a minimum detention time of 24 hours for the design storm event and a minimum length to width ratio of 3 to 1 (NHDES 1992). Where appropriate, a shallow marsh or permanent pool will be included to enhance removal efficiencies and minimize potential re-suspension of accumulated sediments. The shallow marsh or wet-storage volume will be provided by setting the first-flush outlet at least 12 inches above basin floor. The basin will have multiple outlets at varying elevations to detain the smaller runoff events and provide peak flow control for the 2-year and 10-year storm events. An emergency spillway will be provided to pass the estimated peak flow rate produced from 50-year storm event.

The preliminary design assumptions for the proposed grassed swales include a minimum length of 100 feet, a minimum flow depth and flow velocity for a two (2) year storm event of 6 inches and 1.0 feet per second, respectively. The minimum swale slope will be 0.5 percent and total depth of the swale will accommodate the estimated flow volume from 10 year storm event. Research has shown that grassed swales designed in accordance with the above criteria can provide removal efficiencies as high as 80 percent for TSS and 60 percent for other pollutants such as lead. NHDES suggests a more probable range of 20 to 40 percent for TSS and nutrient removal and 10 to 20 percent removal for trace metals. This does not include the additional removal/filtration that may occur in the typical roadside swales located along the roadway that will be used to convey runoff to these storm water Best Management Practices (BMPs).

Another step in the analysis involved a comparison of the percentage of existing and proposed I-93 roadway area within each of the stream watersheds to identify the surface water resources that may be more prone to water quality impacts. The watershed boundaries and the estimated sizes were determined based on the topographic data presented on the relevant US Geological Survey topographic mapping. The estimated size of the drainage area generally refers to the area that is upgradient of the highway corridor. The amount of existing roadway was based on a total pavement width of 76 feet, which includes two 12-foot travel lanes and an inside and outside shoulder width of 4 and 10 feet, respectively, for both the northbound and southbound travel lanes. The amount of roadway area associated

with the existing on and off ramps at each of the interchanges was also included. The estimated proposed roadway area was based on the preliminary design plans for the Four-Lane Alternative. The Four-Lane Alternative would add an additional 68 feet of pavement width or nearly double the existing pavement width of 76 feet (38 feet in each direction). The anticipated new ramp area was also included based on the preferred interchange design options. The Three-Lane Alternative would result in a total of an additional 44 feet of pavement width along the mainline or roughly 35 percent less than the total pavement width under the Four-Lane Alternative.

Phosphorus Impact Methodology

Phosphorus in highway runoff is primarily associated with particulates that accumulate on the pavement. These particulates can be deposited as components of precipitation (rain, sleet or snow) or as dry deposition from fine particulates or dust in the air. Phosphorus in runoff can also be attached to fine sand particles that may be present from previous winter sanding or deicing operations as well as that from sediment that may have eroded along steep embankments. During storm events, the accumulated sediment and attached phosphorus is then washed away and conveyed by highway runoff. Again, it is conservatively assumed that the amount of phosphorus contributed to the area resources will increase proportionally with increased pavement. Thus, if the existing pavement area associated with the roadway is widened by one or two lanes in either direction resulting in an increase pavement area of 50 to 100 percent, respectively, then the associated phosphorus contributions would also increase by a similar amount, without accounting for any water quality treatment that would be included the drainage system.

For most lakes, especially those that have a fair amount of residential, commercial and/or agricultural land use or activity within their watersheds, highway runoff is generally a small component of the total phosphorus load to the lake. There are many other sources of phosphorus including malfunctioning septic systems, lawn and agriculture fertilizers, animal wastes including that from pets, birds and waterfowl, eroded sediments and runoff from parking lots and other impervious surfaces. Even the direct atmospheric contributions to the lake can account for up to 20 percent of the total phosphorus inputs to the lake (USEPA 1986). This analysis focuses on highway runoff from I-93 and does not factor in the contributions from other sources.

Previous sampling efforts conducted by volunteer lake monitoring groups provide existing data on in-lake phosphorus concentrations and other limnological conditions (see Section 3.4.1.2). Using this existing data, the potential changes in the in-lake phosphorus concentrations attributable to I-93 runoff were estimated under the No-Build and Build Alternatives using the modified Vollenweider model, as presented by FHWA (Driscoll et al., 1990). The model calculates an average annual in-lake phosphorus concentration based on the input parameters of

lake surface area, lake volume, the average annual inflow volume and the annual phosphorus load from the highway. The estimated phosphorus load from the highway is based on the roadway area, percent imperviousness in the right-of-way area, the average annual precipitation amount and an assumed phosphorus concentration based on previous sampling data from similar highway conditions.

For each of the project alternatives, an initial phosphorus concentration of 0.5 mg/l[40] was used, which represents the median runoff concentration observed on 50 percent of the urban highway sites that had average daily traffic levels above 30,000 vpd (Driscoll et al., 1990). The median concentration for the rural highway sampling sites was 0.16 mg/l, approximately 1/3 of the assumed initial concentration of 0.5 mg/l. The FHWA Report suggests that one of the primary differences between the urban and rural highway sampling sites was the surrounding land use (Driscoll, et. al, 1990). Urban sampling sites tended to be situated in metropolitan areas with densely developed industrial and commercial land uses, which presumably contribute to higher atmospheric deposition of phosphorus, while the rural highway sites were surrounded mostly with more undeveloped or forested lands, which tend to have lower phosphorus inputs. Since the I-93 roadway corridor has both relatively rural and densely developed land use characteristics, with more densely developed areas to the south, it could be reasonably argued that an appropriate initial phosphorus would be somewhere in between the two median concentrations. A phosphorus concentration of 0.5 mg/l is considered to be a relative high estimate for the project corridor.

In addition, the entire right-of-way area is included in the phosphorus loading analysis and not just the pavement area. This assumption would tend to over-estimate the phosphorus loading attributed to the highway. Moreover, the entire estimated phosphorus load was assumed to be readily available for algal consumption. In comparison, other types of phosphorus loading estimates, such as that used by Maine DEP, assume that 40 to 50 percent of the initial phosphorus load is not readily available since it is attached to settleable particles contained in runoff. Thus, the initial phosphorus load was reduced by 50 to 60 percent prior to factoring in the treatment effects (Maine DEP, 1989).

With regard to the potential treatment effects, in the DEIS analysis it was assumed that the extended-detention basins and the proposed grass swales under the proposed Build Alternatives would reduce the predicted total phosphorus load by 60 and 20 percent, respectively, based on a NHDES guidance document (NHDES 1996). The NHDES document suggests that a pollutant removal efficiency of 10 to 60 percent and 20 to 40 percent can be achieved for extended-detention and grass swales, respectively, by treating the "first-flush' volume of runoff, typically considered to be the first 0.5-inch of runoff from paved surfaces. Recent data presented by the Center for Watershed Protection indicates that grass swales

40 The DEIS had previously stated that an initial concentration of 0.4 mg/l was used but after the coefficient of variation of the sampling data was factored into the analysis, the actual concentration used was 0.5 mg/l.

designed for water quality treatment had median removal efficiencies of 34 and 38 percent for total and soluble phosphorus, respectively (Winer, 2000). Extended-detention basins that had a small permanent pool of water or wetland area had median removal efficiencies of 55 and 67 percent for total and soluble phosphorus, respectively. The study discusses the benefits of having a small permanent pool area, which can enhance particulate settling and prevent re-suspension of sediments during larger storms. However, large pools of water or prolonged standing water and/or saturated soils can sometimes reduce removal efficiencies and in some cases increases phosphorus loading when anoxic conditions prevail. The size of the pool would be limited to no greater than 20 to 25 percent of the total basin area, which is generally standard practice for extended-detention basin design.

Nonetheless, in response to the comments on the DEIS and to remain conservative, the analysis was revised to include a minimum removal efficiency of 40 percent for extended-detention basins, while a removal efficiency of 20 percent was retained for grass swales. As an ultimate worst-case scenario, it can be assumed that only 20 percent of the future phosphorus load would be removed with either the extended-detention basins or grass swales. Again, both the new and the reconstructed roadway will be treated with these measures. The remaining phosphorus is then inputted into the Vollenweider model, as discussed above, to estimate the change in the in-lake phosphorus concentration.

Finally, to minimize the potential phosphorus contributions associated with the use of fertilizers related to the project, NHDOT will specify in the contract bid documents for the proposed project that where fertilizers are to be used in the re-establishment of vegetation in the right-of-way area, only low phosphorus or no phosphorus fertilizers can be used in the watershed areas of Canobie Lake and Cobbetts Pond.

Sodium and Chloride Impact Methodology

In addition to the highway runoff constituents discussed above, additional sodium and chloride will be released to area waters due to the increased deicing applications required to maintain the added travel lanes with the proposed Build Alternatives. The added sodium and chloride conveyed by surface runoff can be a threat to both drinking water quality and aquatic life. NHDES has established a secondary drinking water standard of 250 mg/l for chloride (WS-319.01) to avoid problems associated with taste. Similarly, both acute and chronic aquatic life criteria have been established for chloride associated with sodium at 860 and 230 mg/l, respectively. Excessive levels of sodium and chloride can have detrimental effects on freshwater organisms by disrupting their osmotic balance.

A mass balance analysis was conducted to estimate the long-term average annual concentrations of chloride and sodium in the receiving streams attributable to the I-

93 roadway under the No-Build and the proposed Build Alternatives. The analysis is based on the following assumptions:

- All of the applied road salt reaches the receiving waters with the year of application.
- None of the sodium and chloride is attenuated within the road side soils or proposed treatment measures.
- On average, road salt is applied at annual rate of 22.8 tons per lane-mile based on 10 years of road salt application data for the Manchester to Salem I-93 roadway segment (NHDOT, 2003).
- The average annual recharge to the area streams is equivalent to half of the average annual precipitation or roughly 21 inches, which is equivalent to 1.7 cfs per square mile of drainage area.

Based on comments received on the DEIS, NHDOT conducted a six-month water quality sampling study from December 2002 to May 2003 to document existing chloride concentrations and specific conductance levels in selected streams. (NHDOT, 2003) The results of this study are discussed in Section 3.4.1.3 and are included in the mass-balance procedure to reflect upstream or background levels in streams where data is available. The study scope and results are described further below.

The average annual road salt application rate of 21.0 tons per lane mile used in the DEIS has been revised. The application rate used in the DEIS was based on the average road salt usage on all Interstate highways in southern New Hampshire for the last five years. Subsequently, the NHDOT District 5 Highway Engineer provided annual salt usage data for just the I-93 roadway from Salem to Manchester including interchange and related secondary roadway areas over the last 10 years. (NHDOT, 2002b) Based on this information, the average annual road salt application rate was increased to 22.8 tons per lane-mile, or slightly higher than that previously used in the DEIS analysis (NHDOT 2003).

An estimate of the potential peak chloride concentrations was not included in the impact analysis because it seems much more likely that the chronic criterion could be exceeded rather than the acute criterion since the chronic criterion is nearly 4.0 times lower than the acute criterion. The continuous monitoring data collected by NHDES and USEPA in the 2002-03 winter/spring season supports this assumption. The specific conductance readings recorded from December to April in the Spicket River and Policy Brook levels never exceeded 2,855 µs/cm in either stream, which was determined to be equivalent to the acute chloride criterion of 860 mg/l, (Granato and Smith. 1999). Whereas, the same specific conductance data indicated that in Policy Brook , chloride concentrations exceeded the chronic criterion for much of February and on one occasion in the Spicket River.

Furthermore, the chronic criterion for chloride is inherently based on a 4-day average concentration that occurs no more than once every three years while the acute criterion is based on a one-hour average concentration that may occur at the same frequency. Thus, it seemed most appropriate to base the analysis of predicted future chloride concentrations on average annual conditions where there was reasonable accurate statistical information for road salt applications, precipitation and stream flow based on long-term records. In contrast, there is a general lack of statistical data that would accurately portray the frequency of occurrence for peak or "worst-case" conditions for all the natural factors involved that may produce peak concentrations. The only viable means to adequately evaluate the potential for these peak concentrations is through long-term site-specific sampling studies.

As discussed in detail in Section 3.4.1.3, NHDOT has conducted extensive sampling during the 2002-2003 winter season and this was continued into the 2003-2004 winter season. As part of the 2002-2003 sampling study, fourteen streams were sampled downstream of I-93 and ten of these streams were sampled both upstream and downstream of the I-93 roadway. The streams selected for sampling included those that had readily available access from secondary roads or parking lot areas and did not require direct access from I-93, which is extremely difficult during winter months. The selected streams ranged from the smallest to the largest streams in the project corridor. In addition, two other streams located in the Canobie Lake watershed, which had no I-93 roadway area in their watershed, were also sampled to serve as "reference" streams. A total of 341 samples were collected during twelve sampling events conducted under a variety of weather conditions. During the same period, NHDES and USEPA deployed continuous data-loggers to measure specific conductance levels in four of the larger streams including the Spicket River, Policy Brook, Beaver Brook and Cohas Brook. Due to the worse than normal winter conditions, NHDOT's seasonal road salt usage on I-93 was about 25 percent higher than normal or about 28.2 tons per lane–mile, as compared to ten-year average of 22.8 tons per lane mile. Thus, the observed data collected in this study should reflect higher than normal chloride and specific conductance levels, where road salt applied to I-93 is a major contributing factor.

4.4.1.3 Surface Water Impact Analysis Results

Highway Runoff

Table 4.4-1 presents a comparison of the estimated watershed area, the amount of I-93 roadway area and the percentage of I-93 roadway area in each watershed under the No-Build and proposed Four-Lane Alternative for the twenty-one (21) different streams and rivers that were identified within the project area.

Under the No-Build Alternative, all but one stream in the project area would have less than 5.0 percent of their overall watershed area consisting of the I-93 roadway area. The northeast tributary to Cobbetts Pond, or Dinsmore Brook, would have about 10 percent of its watershed area comprised of I-93 and Route 111 roadway area associated with the Exit 3 Interchange. Nine of the 21 streams would have more than 3.0 percent of their drainage area comprised of I-93 roadway area, which is an impervious threshold suggested by previous research as having a possible negative impact on brook trout populations (see Response #31 to Letter P-1 and the attached Klein Report). The tributary to Harris Brook and the south tributary to Canobie Lake would have the second and third highest percentage of I-93 roadway in their watersheds of 4.2 and 4.0 percent, respectively.

Under the proposed Four-Lane Alternative, three additional streams are estimated to have their watershed imperviousness increase above the 3 percent threshold. The three streams include the tributary to Porcupine Brook, the south tributary to Beaver Brook and the north tributary to Beaver Brook. These streams are relatively small (i.e., approx. 12-15 inches wide), based on field observations, and are located in densely developed areas and are considered to have limited potential for supporting native brook trout populations. See also the descriptions presented in the Aquatic Life discussion (Section 4.4.2). Eleven of the 21 streams are estimated to have less than 5 percent of their watershed area comprised of I-93 and associated interchange roadway area. Only two streams are estimated to have more than 10 percent of their watersheds comprised of I-93 and associated interchange roadway area. The south tributary to Canobie Lake is estimated to have about 11.6 percent of its watershed area comprised of I-93 roadway area. The northeast tributary to Cobbetts Pond or Dinsmore Brook would have the highest estimated percentage of roadway area at 23.0 percent. However, the amount of I-93 roadway area associated with the project represents less than 3 percent of the overall lake watershed areas for both lakes (see further discussion below).

Following the review of the DEIS, the Town of Salem Board of Selectmen and Water Department officials asked NHDOT to direct as much surface runoff to Canobie Lake as practical, and eliminate any existing or proposed drainage diversions that would direct runoff away from the lake. In preparing the DEIS, NHDOT had presumed that the diversion of highway runoff away from the lake was in the best interest of protecting the water supply. However, upon further consultation with Salem officials, it was emphasized that water quantity was just as important as water quality. Thus, NHDOT has changed the preliminary design to direct runoff from about a 2,000-foot section of roadway that currently drains to Porcupine Brook back into the Canobie Lake watershed. This will add about 6.6 acres of roadway area in the south tributary to Canobie Lake watershed and accounts for much of the relatively large increase in the percentage of watershed area associated with the I-93 roadway.

Table 4.4-1 also shows the proposed roadway station locations for extended-detention basins and/or grass treatment swales and the estimated amount of new and reconstructed roadway that could be treated through the use of these measures within each watershed. Project-wide, as many as fifty (50) different extended-detention basins and twenty four (24) grassed swales were roughly sized and located based on a preliminary drainage analysis. The results of the preliminary drainage analysis indicates that with the Four-Lane Alternative, runoff from nearly all the new and reconstructed roadway could be treated by either proposed extended-detention basins or grassed swales. Essentially, the only section of roadway where detention basins or grass swales are not planned include a 500 to 800 foot section at the southerly end of the project area where I-93 transitions back into the existing roadway at the state border. This is primarily due to topographic constraints. This section of roadway drains to the Spicket River, which is not actually crossed by the I-93 roadway and will benefit from the extensive treatment being proposed for its upstream tributaries.

As discussed in Section 4.4.1.2, if nearly 100 percent of the new and reconstructed roadway area under the Four-Lane Alternative can be treated by extended-detention basins (i.e., 60 percent removal efficiency), this could potentially result in a 20 percent reduction in pollutant contributions to each of the surface water resources associated with I-93 runoff relative the No-Build Alternative. If more than 80 percent of the roadway area is treated by extended-detention basins, then no net increase in the pollutant load would be expected. This is based on a conservative assumption that the future pollutant load would increase in proportion to the amount of new roadway area. This also does not include the added treatment effects of the grass swales.

In at least thirteen (13) watersheds, extended detention basins are being proposed to treat runoff from nearly 100 percent of the new and reconstructed roadway area. This includes the key streams that drain to the major area lakes, such as in the northeast tributary to Cobbetts Pond and the south and north tributaries to Canobie Lake. In five (5) other watersheds, at least 80 percent of the new and reconstructed roadway area will be directed to extended-detention basins for water quality treatment while the remaining roadway area will be directed to grass swales designed for water quality treatment. In the other three watersheds, approximately 65 to 75 percent of the new and reconstructed roadway area will be directed to extended-detention basins with the remaining portions draining to grass swales for treatment. The amount of area that could be treated by extended-detention basins in these three watersheds, which include the tributary to Porcupine Brook at Exit 1, the north tributary to Flatrock Brook and the south tributary to Beaver Brook, was limited due to topographic and right-of-way constraints.

As mentioned earlier, additional treatment measures are not proposed for the initial 500-800 feet of roadway draining to the main stem of the Spicket River. The Spicket River will however benefit from the extensive treatment proposed for its tributaries including the tributary to Harris Brook, Policy Brook, Porcupine Brook, and the

Table 4.4.1
Comparison of Drainage Area, I-93 Roadway Area and Percentage of I-93 Roadway Area Associated Within Each of the Watersheds of the Streams and Rivers in the Study Area Under the No-Action and Build Alternatives

		Roadway Area					Proposed Treatment		Percent Treatment[3]	
Water Resource	Est. Drainage Area (ac)	No-Build (acres)	Percent[1] (RA/DA)	Build (4 Lane) (acres)	Percent[1] (RA/DA)	Roadway Stations	Detention Basins	Grassed Swales	Detention Basins	Grassed Swales
Spicket River[2]	>40,000	48.2	0.1	107.5	0.3	NA	NA	NA		
Tributary to Harris Brook	330	13.9	4.2	26.5	8.0	1006-1061 SB 1006-1061 NB	1025 SB[3] 1043 SB	NA	>95 %[4]	NA
Policy Brook	3,500	12.4	0.3	37.7	1.1	1061-1078 SB 1184-1200 SB 1061-1181 NB 1184-1202 NB Exit 1 & 2 NB on/off-ramps Exit 2 Park & Ride Facility	1156 NB 1060 NB 1182 NB	1160 NB 1160 SB	92 %	8 %
Tributary to Porcupine Brook (Exit 1)	350	8.7	2.4	19.4	5.5	1078-1111 SB 1081-1109 NB Exit 1 SB on/off-ramps	1083 SB 1089 NB	1095 SB 1096 NB	72 %	23 %
Porcupine Brook	2,500	24.5	1.0	45.7[5]	2.0	1111-1206 SB 1109-1206 NB Exit 2 SB ramp area	1129 SB 1138 SB 1152 SB 1165 SB 1182 NB	1120 NB 1132 NB	86 %	14 %
South Tributary to Canobie Lake	165	6.6[5]	4.0	19.2[5]	11.6	1202-1260 SB 1202-1259 NB	1216 SB 1240 NB		>95 %	N/A
North Tributary to Canobie Lake	160	5.4	3.3	14.5	9.1	1260-1280 SB 1259-1281 NB[6] Exit 3 Park & Ride Facility	1274 NB	NA	>95 %	NA

Table 4.4-1 (continued)

Water Resource	Roadway Area: Est. Drainage Area (ac)	Roadway Area: No-Build (acres)	Roadway Area: Percent[1] (RA/DA)	Roadway Area: Build (4 Lane) (acres)	Roadway Area: Percent[1] (RA/DA)	Roadway Stations	Proposed Treatment: Detention Basins	Proposed Treatment: Grassed Swales	Percent Treatment[3]: Detention Basins	Percent Treatment[3]: Grassed Swales
Northeast Tributary to Cobbetts Pond - Dinsmore Brook Exit 3 Area	200	19.2	9.6	45.9	23.0	1280-1348 SB 1281-1353 NB NH Rte 111 4300' Exit 3 NB-ramps Exit 3 SB –on ramp Exit 3 SB off 2600'	1305 SB 1308 NB 1311 NB 1313 SB 1318 SB	1321 SB	>95 %	3 %
South Tributary to Golden Brook	210	5.5	3.6	16.1	7.7	1348-1387 SB 1353-1362 NB Exit 3 SB – off 400'	1364 SB 1373 SB	NA	>95 %	NA
North Tributary to Golden Brook	290	9.8	3.4	14.5	5.0	1387-1427 SB 1362-1418 NB	1398 NB 1403 SB	NA	>95 %	NA
South Tributary to Flatrock Brook	125	1.6	1.3	3.1	2.5	1427-1456 SB 1418-1453 NB	1432 NB	NA	>95 %	NA
North Tributary to Flatrock Brook	350	3.7	1.0	7.4	2.1	1456-1473 SB 1463-1472 NB	1474 NB	1445 SB 1446 SB	>65 %	35 %
South Tributary to Beaver Brook	320	5.6	1.7	14.3	4.5	1473-1531 SB 1472-1532 NB	1485 NB 1507 SB 1521 NB	1483 SB 1511 SB 1520 NB	72 %	27 %
North Tributary to Beaver Brook	145	4.0	2.7	8.1	5.6	1531-1553 SB 1532-1554 NB	1555 SB	NA	>95 %	NA

Table 4.4-1 (continued)

	Roadway Area						Proposed Treatment		Percent Treatment[3]	
Water Resource	Est. Drainage Area (ac)	No-Build (acres)	Percent[1] (RA/DA)	Build (4 Lane) (acres)	Percent[1] (RA/DA)	Roadway Stations	Detention Basins	Grassed Swales	Detention Basins	Grassed Swales
Beaver Brook	16,000	19.6	0.1	38.8	0.2	1553-1627 SB 1554-1633 NB Exit 4NB on/off ramp Exit 4 SB on-ramp NH Rte 102 1370'	1571 SB 1583 SB 1599 NB 1606 SB	1617 NB	>95 %	4 %
Tributary to Wheeler Pond formerly Pillsbury Rd. Tributary	550	15.1	3.2	34.5	6.3	1627-1721 SB 1633-1720 NB	1632 NB 1635 SB 1650 NB 1671 NB 1711 SB	1701 SB 1704 SB	83%	17%
Hoods Pond Tributary - near Stonehedge Rd	320	4.9	1.5	9.7	3.0	1721-1749 SB 1720-1746 NB	1733 NB	NA	>95 %	NA
Tributary to Little Cohas Brook	520	18.1	3.5	32.5	6.2	1749-1813 SB 1746-1812 NB Exit 5 on/off ramps 3100 ft of NH 28 Exit 5 Park-and-Ride Facility	1763 NB 1799 NB 1804 SB	Sta 111 NH 28	>95%	5%
Cohas Brook	5,000	38.6	0.8	72.9	1.4	1813-2021 SB 1812-2009 NB	1842 SB 1847 SB 1884 NB 1885 SB 1912 NB 1943 NB 1995 NB	1923 SB 1935 SB 1948 SB 1950 SB 1960 SB 1965 SB 1990 SB	80%	20%

Table 4.4-1 (continued)

	Roadway Area						Proposed Treatment		Percent Treatment[3]	
Water Resource	Est. Drainage Area (ac)	No-Build (acres)	Percent[1] (RA/DA)	Build (4 Lane) (acres)	Percent[1] (RA/DA)	Roadway Stations	Detention Basins	Grassed Swales	Detention Basins	Grassed Swales
Long Pond Brook	370	5.3	1.4	10.5	2.8	1911-1969 NB	1943 NB	NA	>95%	NA
Tributary to Cohas Brook	195	8.6	4.4	10.8	5.5	1990-2009 NB	1995 NB	NA	>95%	NA

1 Estimated percentage of I-93 roadway area within the drainage area based on the preliminary design of the 4-lane alternative.
2 Spicket River is not actually crossed by the I-93 roadway but its watershed includes roadway area within the drainage areas associated with Harris Brook, Policy Brook, Tributary to Harris Brook, Tributary to Porcupine Brook, and Porcupine Brook
3 Indicates proposed roadway station location for treatment measure.
4 Percentage of new and reconstructed I-93 roadway area proposed to be treated by a detention basin and/or grassed swale.
5 Under existing conditions, approximately 2,000 feet of the I-93 roadway between Stations 1215 to 1235 drains away from Canobie Lake and into Porcupine Brook
6 With the proposed "tight-shift" option, approximately 1,500 feet of the northbound lanes will be moved out of the north tributary to Canobie Lake watershed.
NA Not applicable.
RA Roadway area.
DA Drainage area.

tributary to Porcupine Brook, which, on average , are expected to have more than 85 percent of the roadway area treated by extended-detention basins and grass swales. The Spicket River is located at the southern end of the project area and is not actually crossed by the I-93 roadway.

In the watersheds where less than 80 percent of the total roadway area is being proposed for treatment by extended–detention basins there is the potential for a slight increase in pollutant contributions from highway runoff. These streams include the tributary to Porcupine Brook at Exit 1, the north tributary to Flatrock Brook and the south tributary to Beaver Brook. However, given the conservative assumptions used in this analysis, the level of increase is expected to be minimal and not result in any measurable impacts to water quality or their designated uses.

A more detailed drainage analysis will need to be conducted as part of the final design process to verify actual detention basin locations and whether there are any right-of-way acquisition or drainage constraints that might affect the ability to collect runoff along the entire length of roadway or convey runoff to a proposed detention basin location. Additional storm water treatment measures will be included as part of the final design process to treat runoff from the proposed park-and-ride facilities. In general, these facilities are not located directly adjacent to any of the major surface water resources with the exception of the proposed facilities at Exits 3 and 5 which are located within the watersheds of Canobie Lake and Little Cohas Brook, respectively. The pavement area associated with these park-and-ride facilities are estimated to be about 4.0 to 6.0 acres depending on which design alternative is selected. There appears to be adequate space available to construct extended-detention basins near these facilities.

The proposed detention basins will not only be designed for water quality treatment but will provide peak flow control as well. Peak flow control is more crucial in some areas relative to others and could particularly important in the Policy Brook watershed in the southern end of the project area. The residential neighborhood in the Town of Salem, south of Exit 1 and east of I-93 along Haigh Avenue, has experienced flooding problems during large storm events due to rising waters from both Policy Brook and the Spicket River. The preliminary drainage design indicates that runoff from most of the northbound lanes in this area will be diverted to a detention basin on the southbound side due to the lack of available area on the northbound side. This basin will not only provide peak flow control, but would also result in a substantial reduction in the amount of I-93 roadway area draining directly to Policy Brook as compared to that under the No-Build Alternative. It is anticipated that the collection of runoff along the northbound lanes will be accomplished through a drainage swale along the shoulder embankment, built in conjunction with a possible berm that would be created to support a noise barrier.

Phosphorus Loading to Lakes

The phosphorus loading analysis focused on the two principal lakes in the study area, Canobie Lake and Cobbetts Pond. Both of these lakes are extensively used for recreation purposes and Canobie Lake is used as a primary water supply for the Town of Salem. Both lakes are being monitored by volunteer lake monitoring groups and area residents. They have expressed concerns about worsening algal growth and increased nutrient contributions. Substantial increases in phosphorus loading to these lakes could have noticeable impacts to the primary uses of these water bodies. As mentioned earlier, Crystal Lake, located in Manchester, is another important lake used extensively for recreation purposes, however, the relatively small section of the I-93 roadway (i.e., approx. 1,800 feet of the southbound lanes) that is within in its watershed has already been partially widened as part of previous bridge replacement work.

Recent sampling data collected in the summer of 2002 by the NHDES volunteer lake monitoring program (VLAP) indicate that the average phosphorus concentrations in the surface waters (epiliminion) of Cobbetts Pond and Canobie Lake are generally around 10.0 and 12.0 µg/l (micrograms per liter or parts per billion), respectively. As discussed in Section 3.4.1.2, the median summer phosphorus concentration observed in the surface waters of NH Lakes is about 11.0 µg/l, based on the statewide VLAP data. The recent 2002 Bi-Annual Report for Cobbetts Pond indicates that the phosphorus concentrations in the surface layers have not increased over the years since sample collection began in 1988 (NHDES 2002). However, phosphorus concentrations in the deeper water (hypolimnion) have increased from 10 to near 20 µg/l over the years. Whether this increase is due to internal sources (i.e., released from bottom sediments during anoxic conditions) or from external sources (i.e., tributary inflow, shoreline activities, septic system inputs through groundwater, atmospheric deposition, etc.) or other sources has not been determined. Low dissolved oxygen levels at depths below 10 meters or 33 feet have also been recorded by the VLAP volunteers, which would suggest internal organic releases of phosphorus from bottom sediments may be a contributing factor (NHDES 2002).

Subsequent to the review of the DEIS, several revisions and refinements have been made to the estimates of existing and proposed I-93 roadway area that are or would be within the Canobie Lake watershed. Upon further analysis, it was found that about 2,000 feet of the existing roadway located near the Windham/Salem town line currently drains to Porcupine Brook, rather than to the south tributary to Canobie Lake as previously assumed. In addition, portions of the northbound on and off ramp area were also found to be outside the north tributary to Canobie Lake watershed. All totaled, with the adjustments from this further analysis, about 12.0 acres of the existing I-93 roadway area is estimated to be in the Canobie Lake watershed, as compared to the previous estimate of 18.0 acres presented in the DEIS.

With the proposed roadway improvements, about 22.0 acres of new roadway area will be located within the Canobie Lake watershed. About 6.0 acres of the new roadway

area is associated with the proposed Exit 3 park-and-ride facility, which was previously assumed to drain towards Cobbetts Pond. The proposed location of the park-and-ride facility with the Selected Alternative ('tight-shift" option) is essentially along the drainage divide of the two lake watersheds. Upon further analysis of the potential grading and terrain changes, it was determined that runoff from this facility would end up in the Canobie Lake watershed. Another 6.6 acres of new roadway area will be added to the south tributary to Canobie Lake due to the proposed diversion of runoff from along a roadway section near the Windham/Salem town line that currently flows to the Porcupine Brook watershed. This diversion back into the Canobie Lake watershed is in response to the request made by the Salem Board of Selectmen and Water Department officials.

The added roadway area is offset to some degree by the fact that approximately 1,500 feet of the northbound lanes (Stations 1280-1298) and the remaining portions of the northbound off-ramp will be relocated out of the watershed with the "tight-shift" option. Nearly 4,500 linear feet of existing NH 111 between Exit 3 and NH 28 are also in the watershed. Runoff from all new and reconstructed I-93 roadway area within the watershed will be directed to proposed extended-detention basins. The expected benefits of these treatment measures are included in the results of phosphorus loading analysis.

Within the Cobbetts Pond watershed, an estimated 7,000 linear feet the proposed I-93 roadway (Stations 1280-1350) or roughly 23 acres of the I-93 mainline will drain to Cobbetts Pond. Another 22.0 acres associated with the Exit 3 Interchange ramp area and about 6,000 linear feet of the NH 111 roadway will also drain to Dinsmore Brook, which outlets in the northeast corner of Cobbetts Pond. Overall, the amount of new or reconstructed roadway area in this watershed is expected to be about 45.4 acres with the Four-Lane Alternative, which represents about 2.2 percent of the entire lake watershed. As many as five extended-detention basins are being proposed to treat all of the new and reconstructed roadway area associated with the I-93 and Exit 3-Interchange area. Two grass swales are also being proposed to treat runoff from the westerly portions of the reconstructed NH 111 roadway area within the Cobbetts Pond area.

As mentioned earlier, the in-lake phosphorus concentrations associated with highway runoff from the existing roadway, as well as the potential changes that may occur under the proposed Four-Lane Alternative, were estimated using a modification to the Vollenweider model as presented by FHWA (Driscoll 1990). The initial phosphorus concentration in runoff was assumed to be 0.5 mg/l, which is considered to be conservatively high, and represents the median concentration that was observed in 50 percent of urban highway sampling locations. The concentration was assumed to be the same under both existing and proposed conditions since the primary source is linked to atmospheric deposition and is not expected to change as a result of the project. The primary change will be reflected in the total phosphorus load as a result of the increased runoff volumes. The model procedure is suitable to project the relative change between existing and proposed conditions attributable to highway runoff, but

does not account for other sources that may contribute to future in-lake phosphorus concentrations.

Table 4.4-2 presents the results of the phosphorus loading analysis for each lake under existing and proposed conditions with various treatment effects factored in. The results indicate that under existing conditions highway runoff potentially contributes as much as 14 to 24 percent of the total phosphorus concentration in Canobie Lake and Cobbetts Pond, respectively. Under the proposed Four-Lane Alternative, assuming a removal efficiency of 40 percent with the proposed extended-detention basins, the analysis indicates that the in-lake phosphorus concentrations could increase by 0.7 and 0.6 µg/l in Canobie Lake and Cobbetts Pond, respectively. As much as 19 to 26 percent of the in-lake phosphorus concentration could be attributable to highway runoff.

Even with a removal efficiency of only 20 percent with grassed swales, the in-lake phosphorus concentrations in Canobie Lake and Cobbetts Pond are estimated to increase by only 1.5 and 1.6 µg/l to 13.5 and 12.6 ug/l, respectively. These projected

Table 4.4-2
Comparison of the Estimated In–Lake Phosphorus Concentration (µg/l) Attributable to Highway Runoff From I-93 with the Total In–Lake Phosphorus Concentration Under the Various Project Alternatives

	Canobie Lake			Cobbetts Pond		
Alternative	Highway Runoff (ug/l)	Total Conc.(ug/l)	% Total	Highway Runoff (ug/l)	Total Conc.(ug/l)	% Total
No-Build	1.7[1]	12.0[2]	14%	2.4[1]	10.0[2]	24%
Build Alternatives w/out treatment	4.0	14.3	28%	5.0	12.6	40%
Build Alternative w/ Detention Basin (40% Removal)	2.4	12.7	19%	3.0	11.6	26%
Build Alternative w/Grassed Swale (20% Removal)	3.2	13.5	24%	4.0	12.6	32%

1 Represents the portion of the estimated in-lake phosphorus concentration attributable to runoff from the I-93 roadway.
2 The total concentration represents the existing in-lake phosphorus concentration as provided from existing data plus any future increase as predicted by the model under future conditions.

increases are relatively minor given the existing total in-lake concentrations of 12 and 10 µg/l and are not expected to cause a discernable or measurable change in water quality conditions in either lake. The projected increases are relatively small for several reasons but primarily because runoff from both the existing and newly proposed roadway area will be treated and the amount of I-93 roadway represents a small percentage of the overall lake watershed. The total amount of new and reconstructed roadway area represents about 2.2 and 2.4 percent of the overall lake watershed area for Cobbetts Pond and Canobie Lake, respectively. Less than a third of the total predicted future in-lake phosphorus concentrations are expected to be associated with highway runoff meaning the majority of the phosphorus inputs will continue to be derived from other sources.

Road Salt Impact

Table 4.4-3 presents the results of the road salt impact analysis showing the estimated roadway lane miles, average annual chloride application (tons), and the predicted average annual downstream chloride concentration for both the No-Build Alternative and proposed Four Lane Alternative. As mentioned earlier, the average annual road salt application rate used was 22.8 tons per lane-mile, based on recent road salt usage data provided by the District 5 Maintenance Engineer (NHDOT 2002). In addition, the number of lane-miles within the watersheds of the north and south tributaries to Canobie Lake were also revised based on additional review of the existing and proposed drainage patterns. The total lane-miles for the I-93 roadway are consistent with the estimated lane-miles provided by the District 5 Engineer and include ramp area, rest areas, weight stations and other secondary road areas associated with the interchanges. Finally, an upstream or "background "concentration, based on the recent sampling study, was included in the analysis for ten different streams that had available upstream data. For other streams that had no upstream data, an average upstream concentration of 47. 0 mg/l was used based on an average of the observed data for other similar-sized streams. This includes the south tributary to Canobie Lake, Dinsmore Brook, the south tributary to Beaver Brook, the Hoods Pond tributary and Little Cohas Brook. The upstream concentration data for the other larger streams or streams that are clearly influenced by other major sources of chloride such as the Spicket River, Policy Brook, tributary to Harris Brook, Beaver Brook and the tributary to Wheeler Pond were not used in calculating the average upstream concentration.

Refer to Section 3.4.1.3, for a more complete discussion of the recent chloride data and the scope of the sampling study. It is important to mention that the observed concentrations were measured during a season when the seasonal road salt usage on I-93 was about 25 percent higher than average due to the severe winter conditions that occurred during the 2002/2003 winter season.

No-Build Alternative

Under the No-Build Alternative, the predicted average annual chloride concentrations range from 48.7 to 200.0 mg/l within the various streams. None of the streams are estimated to have an average annual chloride concentration above the aquatic life criteria of 230 mg/l for chloride. It is recognized that average annual chloride concentrations are typically lower than the potential peak concentrations that may occur during winter months. However, since all the applied salt was conservatively assumed to enter the stream with no losses to groundwater, the predicted average annual chloride concentrations were actually higher than the observed seasonal average concentrations for most streams in the road salt sampling study. Additional continuous specific conductance levels measured by USEPA and NHDES every 15 minutes throughout the winter indicate the peak chloride concentrations never exceeded the acute criteria of 860 mg/1 in the sampled streams.

Table 4.4-3
Summary of Observed and Estimated Average Chloride (Cl) Concentrations in Each Stream for the No-Action and Four Lane Build Alternatives

Water Resource	Watershed Data		No - Build Alternative				Build Alternative (4-Lane)		
			Highway Runoff		Predicted Stream Conc.[3]	Observed Dwnstrm Conc.[4]	Highway Runoff		Future Stream Conc.[5, 6]
	Drainage Area	Observed Upstream Conc.[2]	Road Area	Annual CL Load			Road Area	Annual CL Load	
	acres	mg/l	Ln-miles	tons	mg/l	mg/l	Ln-miles	Tons	mg/l
Spicket River[1]	>40,000	91	20.2	276.74	93.6	119.0	41.1	563.1	96.5
Harris Brook	3,200	47*	5.0	68.50	55.4	na	10.0	137.0	64.1
Policy Brook	3,500	187	4.3	58.91	192.5	213.0	8.6	117.8	199.0
Trib to Harris Brook	320	143	3.0	41.10	185.4	149.0	6.0	82.2	231.6
Trib to Policy Brook (Exit 2)	350	47*	3.6	49.3	99.5	na	5.4	74.0	127.2
Porcupine Brook	2,180	47*	8.0	109.60	66.6	na	15.9	217.8	86.3
South Trib to Canobie Lake	165	35	3.0	41.10	124.8	85.0	8.8	120.6	276.1
North Trib to Canobie Lake	160	47*	2.3	31.51	118.6	218.0	8.8	120.6	291.7
Trib to Cobbetts Pond-Dinsmore Brk Exit 3	200	14	8.4	115.08	200.0	154.0	13.5	185.0	309.0
South Trib to Golden Brook	210	47*	1.8	24.66	91.2	na	3.8	52.1	140.0
North Trib to Golden Brook	290	47*	3.7	50.28	110.7	67.0	7.3	100.6	173.2
South Trib to Flatrock Brook	125	47*	1.9	26.03	122.3	na	3.8	51.5	194.2
North Trib to Flatrock Brook	350	47*	2.1	28.77	78.5	77.0	4.2	57.5	110.3
South Trib to Beaver Brook	320	88	2.8	38.63	131.1	97.0	5.7	78.4	176.9
North Trib to Beaver	145	47*	1.7	22.74	105.0	55.0	3.3	45.5	162.3
Beaver Brook	16000	98	7.6	103.98	100.4	99.0	15.2	208.2	103.0
Trib to Wheeler Pond	550	107	4.9	67.13	149.5	133.0	9.6	131.5	192.5
Hoods Pond Trib.	320	61	4.8	65.76	134.1	71.0	9.6	131.5	206.2
Little Cohas Brook	520	38	7.8	106.86	113.2	85.0	15.6	213.7	185.9
Long Pond Brook	370	47*	4.1	56.17	103.3	na	8.2	112.3	159.0
Cohas Brook	>5,000	40	8.0	109.60	48.7	66.0	16.0	219.2	57.6
Tributary to Cohas Brook	195	47*	1.4	19.73	85.4	na	2.9	39.5	124.0
Total Ln-Miles			110.4[7]				223.3		

Notes:

1 No direct runoff to Spicket River. Estimated loading includes contributions to Harris Brook, Policy Brook, and Porcupine Brook

2 Observed upstream chloride concentrations represent background concentrations based on the average concentrations measured in the road salt sampling study. An * denotes that there was no upstream data available for this stream and, therefore, an estimated upstream concentration is used based on data from other small to moderate sized streams including the south tributary to Canobie Lake, Dinsmore Brook, N. Trib to Golden Brook, S. Trib to Flatrock Brook, S. Trib to Beaver Brook, Hoods Pond tributary and Little Cohas Brook.

3 The predicted concentration is based on the mass balance procedure accounting for the average annual road salt application rate, average annual recharge and average annual stream flow. The predicted concentration includes the upstream or background concentration.

4 The observed downstream concentration is based on the average concentration observed in the road salt sampling study (see Table 3.4-1).

5 The estimated future average chloride concentration includes an upstream or "background" concentration.

6 The estimated future chloride concentrations do not reflect the expected salt use reductions and increased efficiencies anticipated with the proposed change to snow and ice control program and equipment upgrades as discussed in Section 4.4.1.5 Maintenance Measures.

7 The total lane-miles for the No-Build Alternative is consistent with the total lane miles provided by the District 5 Engineer in the December 5, 2002 Road Salt Use Summary Memorandum and includes the I-93 main line, ramps, rest area and other ancillary road areas.

8 Specific conductance levels above 850 and 2,855 µs/cm max indicate a potential exceedance of the chronic and acute aquatic life criteria of 230 and 860 mg/l, respectively.

Dinsmore Brook has the highest predicted average annual chloride concentration due to the relatively high percentage of I-93 main line and related interchange roadway area in its watershed. Nearly the entire Exit 3 Interchange and about 1.3 miles of the I-93 main line is within its watershed. The predicted average annual downstream chloride of 200 mg/l was about 30 percent higher than the average seasonal downstream concentration of 154 mg/l observed in the road salt sampling study. In fact, in 11 of the 15 streams that have observed downstream data, the predicted average annual concentrations for the No-Build Alternative are generally higher than the observed seasonal average concentrations. This is indicative of the conservative assumptions used in the mass balance procedure.

In contrast, there are several streams where the average observed concentration is higher than the predicted average annual concentration including the Spicket River, Policy Brook and the north tributary to Canobie Lake. This would suggest that the chloride contributions from other sources in the watershed are having an overriding effect on the chloride concentrations in the stream. In particular, the north tributary to Canobie Lake had an average observed downstream concentration of 218 mg/l, which is 100 mg/l higher than the predicted average annual chloride concentration. This is by far the largest difference between the observed and predicted data as seen in any of the streams. As discussed earlier in Section 3.4.1.3, a possible source may relate to the water softening process used in the nearby Pennichuck Water Works wells, which are located about 200 to 300 feet from the sampling location and Canobie Lake. As part of the treatment process, potassium chloride is added to the water and the backwash wastewater from the treatment system is discharged into an onsite dry well that infiltrates into the groundwater or nearby wetlands. NHDES has issued a permit to discharge as much 750 gallons per day. The added chloride from this treatment process can end up in Canobie Lake through both the backwash discharge and from the septic leachate associated with the 200 or more homes along the western shores of Canobie Lake that are connected to the well.

Several streams have a relatively small (i.e., within 10 to 20 percent) difference between the observed upstream concentration and either the observed or the predicted downstream concentration, which means that the road salt applications on I-93 are having only a minor effect on the chloride concentrations in these streams. These streams include the tributary to Harris Brook, Porcupine Brook, Beaver Brook and even Cohas Brook. These are generally streams with the larger watersheds. These streams also tend to be the most important from an aquatic habitat and fisheries perspective (See Section 3.4.1.4 on Aquatic Life).

With respect to existing peak chloride concentrations, the USEPA deployed data loggers during the winter 2002/03 in Policy Brook and the Spicket River to continuously measure specific conductance levels at 15-minute intervals. Policy Brook had relatively high specific conductance levels, which corresponds well to some of the highest chloride concentrations of the 15 streams sampled downstream of I-93 according to the data collected by NHDOT (see Table 4.4-3). Based on a

regression analysis, correlating specific conductance levels to chloride concentrations, chloride concentrations never exceeded the acute water quality criteria of 860 mg/l. The data did show, however, that the chronic water quality criteria of 230 mg/l was exceeded during much of February (NHDOT 2003).

Additional specific conductance data collected by the USEPA, upstream of the I-93 roadway, indicated that existing specific conductance levels are also elevated throughout much of the watershed. In fact, in at least one location, the recorded upstream level was higher than that measured level downstream of the roadway on the same day. These elevated levels suggests that this a regional problem particularly in the southern end of the project area and are presumably due in large part to the amount of commercial development and densely developed residential areas in this watershed. The same is true for the tributary to Harris Brook, which has relatively high chloride concentrations and yet no major roadways within its watershed.

Build Alternative (Four-Lane)

Under the proposed Four–Lane Alternative, six streams have predicted average annual chloride concentrations that are above 200 mg/l and are close to or exceed the chronic life criteria. Four streams including the tributary to Harris Brook, the south and north tributaries to Canobie Lake, and Dinsmore Brook have predicted future chloride concentrations above the chronic life criteria. However, for two of these streams, including the tributary to Harris Brook and the north tributary to Canobie Lake, much of the predicted increase in the future concentrations is due to sources other than the proposed roadway improvements. This is based on the fact that the chloride concentrations upstream of I-93 are already elevated and account for a large portion of the future predicted concentrations downstream. For these streams, any measure potentially considered by NHDOT to reduce loadings to these streams would have a limited effect on reducing chloride concentrations as other sources are the major contributors as the data suggest.

Policy Brook also appears to be currently affected by existing sources of chloride in the watershed other than I-93. The existing average upstream chloride concentration was 187 mg/l, which is only 14 percent lower than the average downstream concentration as discussed in Section 3.4.1.3. The same is true for the tributary to Harris Brook, which had relatively high chloride concentrations upstream and yet there are no major roadways within its watershed. The average downstream chloride concentration in the tributary to Harris Brook was essentially the same as the observed upstream concentration.

Based on the results, Dinsmore Brook and the south tributary to Canobie Lake could be affected the most by future road salt applications on the I-93 roadway based on the relatively large predicted increase in chloride concentrations. The future average chloride concentrations are predicted to exceed the chronic aquatic life criteria. The relatively large increase predicted for the south tributary to Canobie Lake is primarily due to a proposed change in drainage direction, where nearly 0.5 mile of

roadway that currently drains to Porcupine Brook will be diverted back into the Canobie Lake watershed. This change was made as a result of a request by the Salem Board of Selectmen and Water Department officials to maximize the amount of surface water recharge to the lake.

Both Dinsmore Brook and the south tributary to Canobie Lake are relatively small with estimated watershed areas of about 200 acres or less. Neither stream is considered to provide regionally important aquatic habitat because of their small watershed size and limited stream lengths. The aquatic habitat in Dinsmore Brook also appears to be affected somewhat by the abundance of iron floc observed over much of it substrate, presumably due to low oxygen conditions. Both streams do, however, contribute flow to two important lakes in the area.

Dinsmore Brook would have the highest percentage of I-93 roadway area within its watershed with an approximately 20 acres or 13.5 lane-miles of I-93 under proposed conditions. Due to the local topography, there are essentially no opportunities to divert flow out of the watershed. The proposed diamond interchange design for Exit 3 will make travel conditions safer and eliminate the existing geometrically deficient curves on the ramps that presently may require occasional "heavy" or repeat salt applications during severe winter conditions to prevent accidents and particularly rollovers.

Two other streams, the tributary to Harris Brook and the north tributary to Canobie Lake, also have predicted future chloride concentrations that exceed the chronic life criteria. As discussed above, both of these streams already have elevated upstream chloride concentrations that are due to sources other than I-93. The north tributary to Canobie Lake, in particular, appears to be affected greatly by the water treatment process occurring in the nearby community well, as discussed earlier. The source(s)of chloride in the tributary to Harris Brook watershed are unknown at this time.

Although this analysis focuses primarily on the Selected Four-Lane Alternative, since it represents the worst-case scenario, a separate cursory analysis of the Three-Lane Alternative indicates that the predicted average annual chloride concentration in both Dinsmore Brook and the north tributary to Canobie Lake are still predicted to exceed the chronic aquatic life criteria. The predicted average annual concentration for the tributary to Harris Brook and south tributary to Canobie Lake would be just below the criteria, while the predicted concentration for Policy Brook would be about the same due to the greater influence from upstream sources.

NHDOT believes that even though the proposed Four-Lane Alternative will result in twice the number of existing travel lanes, the future road salt applications will not necessarily be twice the amount currently applied to the existing I-93 roadway. As noted previously, the mass balance methodology of predictive future levels is highly conservative in that it assumes that salt applications will be doubled with the widened highway, and the salt all finds its way into surface waters directly

downstream of the highway. No salt is assumed to be attenuated within roadside soils or proposed treatment measures. Additionally, there are a number of efforts NHDOT will pursue focusing on optimizing application of road salt through better management practices, improved maintenance decision support, advances in application technology and promoting awareness and efficiencies through training and education at both state and the local level which will reduce salt usage compared to existing and historic practices. Refer to Mitigation Section 4.4.1.5 for additional discussion about improving application efficiencies and the use of alternative deicers.

The use of alternative non-chloride deicers as a possible means of reducing sodium and chloride inputs to Cobbetts Pond or Canobie Lake could be considered. However, effective alternative deicers are typically not practicable, cost-effective solutions for extended lengths of roadways with additional equipment costs and substantially higher material costs approximately 30 times that of conventional salt use. Additionally, this possible remedy would potentially only trade one water quality problem for another. Most of the non-chloride based deicers, which are typically produced from organic, grain based or acetate based materials (e.g., Calcium Magnesium Acetate, Potassium Acetate) have been found to contain high levels of nutrients and/or oxygen-demanding substances, and can present other major water quality concerns for downstream lakes and ponds (Transportation Research Board 2001).

Summary

There are twenty-one different streams and rivers that were identified within the project corridor, which extends for nearly 20 miles from the Massachusetts border to the I-93/I-293 Interchange in the City of Manchester. There are two relatively large rivers in the study area (Spicket River and Beaver Brook) with watershed areas of well over 10 square miles. There are also several moderately sized streams including Policy Brook, Porcupine Brook and Cohas Brook with estimated watershed areas of about 3 to 10 square miles. The remaining streams are considered to be small headwater or tributary streams with estimated watershed areas of less than 1.0 square mile or 640 acres. Several of these small streams may only support seasonal flow and limited aquatic habitat. All of the streams are classified as Class B waters, except for Canobie Lake, which is a Class A water body because of its use as a public water supply. None of the streams are considered suitable for supporting native cold water fisheries, although Cohas Brook and Beaver Brook have been stocked on an annual basis with trout species downstream of the project area. All of the identified streams and rivers are currently affected to some degree by highway runoff from I-93 as well as other roadways and developed areas.

The project corridor also includes two important lakes, specifically Canobie Lake and Cobbetts Pond. Both are located primarily in the Town of Windham and just south of the Exit 3 Interchange. Both lakes are extensively used for recreation purposes and Canobie Lake serves as the primary public water supply source for the Town of Salem. These lakes have shown signs of increased algal growth, reduced water clarity

and a decline in dissolved oxygen levels in the bottom layers. This trend is presumably due to increased nutrient inputs, especially phosphorus, as a result of existing and increased development within the watershed and runoff from paved surfaces including the I-93 roadway.

As a worst-case assumption, under the proposed Four-Lane Alternative, it was assumed that the pollutant concentrations in highway runoff would be twice as high as existing levels, consistent with the amount of new roadway area. However, based on the preliminary drainage design, runoff from nearly all of the new and reconstructed roadway area would be directed to either an extended-detention basin or a grass swale for water quality treatment. Properly designed, extended-detention basins and grass swales have been shown to provide average pollutant removal efficiencies of 60 and 20 percent, respectively, for pollutants associated with particulates. With the current design objective of treating runoff from all of the new and reconstructed pavement area through the use of extended-detention basins, this should result in a 20 percent reduction in the existing theoretical pollutant load to each of the streams associated with highway runoff. This would result in a substantial water quality benefit for the area water resources compared to the existing, no-build conditions.

Project-wide, the preliminary drainage analysis indicates that close to 50 different extended-detention basins and 24 grass swales could be constructed at various locations along the project corridor. In at least thirteen watersheds, more than 95 percent of the roadway area could be treated by extended-detention basins. This includes several key watersheds including the north tributary to Canobie Lake and the northeast tributary to Cobbetts Pond and Beaver Brook. In these watersheds, as mentioned above, a net reduction in the pollutant load attributable to highway runoff is anticipated in comparison to the No-Build Alternative.

In five (5) other watersheds, more than 80 percent of the roadway area will be treated by extended-detention basins while the remaining roadway will be treated by grass swales. In these watersheds, no substantial increase in the pollutant load is anticipated relative to the No-Build Alternative. In three watersheds including the tributary to Porcupine Brook at Exit 1, the north tributary to Flatrock Brook and the south tributary to Beaver Brook, 65 to 73 percent of the total roadway area will be treated by extended–detention basins with the remaining roadway area directed to grass swales. In these streams, there is the potential for a slight increase in pollutant contributions from highway runoff based on the conservative assumptions used in this analysis. The level of increase is expected to be minimal and not result in any measurable impacts. Spicket River is also expected to have minimal water quality impacts as a result of the extensive treatment measures proposed along its tributaries.

With a removal efficiency of only 20 percent, a slight increase of 1.5 and 1.6 µg/l in the in-lake phosphorus concentration is expected for Canobie Lake and Cobbetts Pond, respectively, relative to the No-Build Alternative. The potential phosphorus

increases are expected to be even lower with a removal efficiency of 40 percent, which is considered to be more likely with the proposed extended-detention basins. Less than one-third of the total in-lake phosphorus concentrations in both lakes is expected to be associated with highway runoff under proposed conditions. Overall, the total amount of new and reconstructed roadway area for the Four-Lane Alternative represents about 2.2 and 2.4percent of the overall lake watershed area for Cobbetts Pond and Canobie Lake, respectively.

Under the proposed Four–Lane Alternative, the mass-balance procedure indicates that future chloride concentrations could potentially exceed the chronic life criteria in four streams. These streams include the tributary to Harris Brook, the south and north tributaries to Canobie Lake, and Dinsmore Brook. Also, Policy Brook currently has elevated chloride levels and a predicted future concentration that approaches the chronic criteria. For the tributary to Harris Brook, Policy Brook, and the north tributary to Canobie Lake, much of the existing chloride concentrations are due to sources other than the I-93 roadway given the fact that the upstream concentrations are already elevated and are not predicted to be substantially affected by I-93. The elevated chloride concentration upstream of I-93 emphasizes that this is a regional issue and any measure potentially considered by NHDOT to reduce loadings to these streams would have a limited effect. A comprehensive regional approach is required to meaningfully address this issue.

Overall, Dinsmore Brook and the south tributary to Canobie Lake could be affected the most based on the predicted increases in the average annual chloride concentrations. The relatively large increase predicted for the south tributary to Canobie Lake is largely due in part to a proposed change in drainage direction, where nearly 0.5 mile of roadway that currently drains to Porcupine Brook will be diverted back into the Canobie Lake watershed. This change was made based on a request by the Salem Board of Selectmen and Water Department officials to maximize the surface recharge to the lake.

For Dinsmore Brook, there are essentially no opportunities to divert flow out of the watershed due to the local topography. The proposed diamond interchange design will make travel conditions safer and eliminate the existing geometrically deficient curves on the ramps that presently may require occasional “heavy” or repeat salt applications during severe winter conditions to prevent accidents and particularly rollovers. The approximately 3-mile segment of roadway near the Exit 3 Interchange that spans the watersheds of both Dinsmore Brook and both the north and south tributaries of Canobie Lake will be the focus of attention in improving snow and ice control policies and maintenance measures as discussed in Section 4.4.1.5.

The use of alternative non-chloride deicers as a possible means of reducing chloride inputs could be considered but are typically not practicable, cost-effective solutions and could introduce other water quality concerns. Most of the non-chloride based deicers, which are typically produced from organic, grain-based or acetate-based materials (e.g., Calcium Magnesium Acetate, Potassium Acetate) have been found to

contain high levels of nutrients and/or oxygen-demanding substances, and can present other major water quality concerns for downstream lakes and ponds (Transportation Research Board 2001).

4.4.1.4 Secondary Impacts

The potential effects of secondary development on water quality are difficult to assess because so much depends on when, where, and in which watersheds the secondary development will occur. As it was discussed earlier, the proposed project is expected to result in no major increases in the various pollutants associated with particulates contained in highway runoff. This is because the proposed project will treat runoff from both the existing and new roadway area with extended-detention basins and grassed swales. Assuming a typical removal efficiency of 60 percent or more, based on previous research results, most streams in the project corridor will theoretically receive less pollutant contributions from the I-93 roadway than under existing conditions. This provides some buffer against possible future increases in pollutant contributions from other sources including secondary development.

Perhaps the most substantial concerns associated with secondary development relate to the potential increases in chloride concentrations in streams associated with additional septic systems, water softening treatment, and road salt applications. Increased nutrient loading, particularly in the lake watersheds, is also a principal concern. A recent US Geological Survey report indicates that the mean-annual chloride concentrations in the Merrimack River have increased dramatically over the last 100 years or so. The mean-annual concentration increased from 2.9 to 24.9 mg/l from the early 1900's to the late 1990's, which represents a nearly 10-fold increase. However, it would require nearly another 10-fold increase for the mean-annual concentrations to reach the chronic aquatic life criteria, the concentration considered harmful to aquatic life. Similarly, the mean-annual nitrate concentrations increased an order of magnitude from 0.04 mg/l to 0.33 mg/l, but these concentrations are still well below the USEPA human health criteria of 10 mg/l (Robinson et. al., 2002). Given the more stringent state and local regulations adopted in the last decade or two associated with storm water management, septic system design and natural resource protection (i.e., wetland delineation, buffer setbacks, etc.) and with the use of Best Management Practices (BMPs), present and future development would be expected to produce smaller incremental changes in water quality than previous development.

4.4.1.5 Mitigation

Design Elements

Based upon the preliminary drainage design, as many as 50 different extended-detention basins and 24 grass swales will be included in the project design for water quality treatment. Runoff from the entire length of new and reconstructed roadway

will be treated including the park-and-ride facilities and the secondary roads and ramps associated with the interchange areas. In the vicinity of the Exit 3 interchange, I-93 is proposed to be relocated toward the median to reduce the overall footprint of the interchange and provide additional buffer area between the highway and Canobie Lake and Cobbetts Pond to enhance water quality protections and opportunities to these sensitive water resources. The stormwater treatment measures will be designed to maximize treatment efficiencies. The extended detention basins will include a sediment forebay, small pocket wetland, a 4 to 1 length to width ratio and spill containment devices for basins located in the Canobie Lake and Cobbetts Pond watersheds. The grass swales constructed specifically for water quality treatment will be designed with a minimum length of 100 feet, a minimum flow depth and flow velocity for a 2-year storm event of 6 inches and 1.0 foot per second, respectively. The minimum swale slope will be 0.5 percent and total depth of the swale will accommodate the estimated flow volume from 10-year storm event. Typical grass drainage swales will also be utilized in the project to collect and convey storm water runoff and, although these may provide supplemental treatment benefits, they were not included in the impact analysis.

In the vicinity of Canobie Lake, the drainage design, treatment swales, and detention basins will include specific spill containment measures to capture and isolate any inadvertent hazardous material spills from the highway before they reach Canobie Lake.

Opportunities to divert runoff outside of the watersheds of Canobie Lake and Cobbetts Pond have been explored, but given the local topography there are few opportunities available. Currently, runoff from about a 0.5 mile section of I-93 roadway near the Windham/Salem town line flows out of the Canobie Lake watershed and into the Porcupine Brook watershed. It was previously considered in the DEIS, to maintain this diversion of runoff and perhaps divert additional roadway out of the watershed. However, the Salem Board of Selectmen have asked NHDOT to divert flow back into the Canobie Lake watershed to maximize the surface recharge to the Lake as water quantity is as critical to the water supply as quality. There are essentially no opportunities to divert roadway runoff out of the Cobbetts Pond watershed.

NPDES II

The USEPA's National Pollution Discharge Elimination System (NPDES) Phase II program expands the Phase I program by requiring additional operators of Municipal Separate Storm Sewer Systems (MS4s) in urbanized areas and operators of small construction sites to implement programs and practices to control polluted storm water runoff. USEPA-Region 1 is the Permitting Authority in New Hampshire and has issued the following general permits to address these subject areas:

1. National Pollutant Discharge Elimination System (NPDES), General Permit on Storm Water Discharges from Small Municipal Separate Storm Water Systems, and

2. National Pollutant Discharge Elimination System General Permit for Discharges from Large and Small Construction Activities (aka Construction General Permit (CGP)).

Under the NPDES Phase II program, a Small MS4 is any MS4 that was not already covered by the NPDES Phase I program as a "medium" or "large" MS4. There are 45 regulated communities in New Hampshire, which include the city of Manchester, and the towns of Londonderry, Salem, and Windham. It includes the entire city of Manchester, and portions of the towns of Londonderry, Salem and Windham. In addition, the NHDOT is also regulated because they own and operate stormwater conveyances that are contained within the regulated portions of these communities. All regulated Small MS4 operators must develop, implement, and enforce a stormwater management program to reduce or eliminate the discharge of pollutants to the "maximum extent practicable". The above-mentioned cities and the NHDOT were required to submit individual Notice of Intents (NOIs) to EPA-Region 1 that note their intentions in meeting the Small MS4 regulations. The NOI also includes a 5-year stormwater management plan summary that addresses the required six Minimum Measures as outlined in the permit. In addition, regulated operators are required to prepare annual reports detailing the activities and efforts that were undertaken and how measurable goals were met.

NHDOT has also recently established a statewide 5-Year Storm Water Management Plan as part of the NPDES Phase II Permit Program, that includes conducting periodic education and outreach efforts to share ideas and information with NHDOT personnel, local officials and contractors. These outreach efforts will include efforts to promote more efficient application and storage techniques for road salt through improved technology. NHDOT will also coordinate with regulated small MS4 communities in addressing storm water management and treatment measures, eliminating any illicit discharges within the storm drain systems and implementing pollution prevention and good housekeeping measures.

Maintenance Measures

The best management practices for road salt are to optimize the use of material to maximize efficiency and effectiveness of application, thereby using as minimum amount as practicable to improve environmental protection without compromising safety. NHDOT will continue to explore new technologies and equipment to improve maintenance decision-making, and increase efficiency to optimize overall use of road salt. The proposed project will incorporate a Road Weather Information System (RWIS), which allows highway maintenance staff to have real-time pavement temperature and moisture data using sensors embedded in the pavement. This will be part of a statewide network of RWIS installations associated with the multi-state ITS effort. The data enables minimization of chemical application, improved safety and elimination of the uncertainty that leads to potentially unnecessary applications. NHDOT plans to utilize the Maintenance Decision Support System (MDSS), an

advanced decision support tool for winter maintenance managers, being developed and field tested by FHWA. This system provides systematic recommendations and suggested treatments to maximize the efficiency of winter maintenance operations to reduce salt usage with precision timing of material application.

The improved geometry and correction of existing geometric deficiencies particularly in the Exit 3 area, will also diminish to some extent the frequency of applications and early or repeated callouts.

NHDOT has in recent years, begun applying the technique of "pre-wetting" road salt, which increases the effectiveness of salt by limiting the amount of salt scatter and keeping deicing material on the pavement surface. NHDOT will expand and standardize the use of these techniques on the I-93 corridor as equipment is replaced and upgraded. NHDOT also employs ground-oriented spreader application of road salt and continues to standardize its I-93 maintenance fleet with this equipment. With this technique, the material application rate is computer-calibrated to the speed of the vehicle to maintain a consistent, uniform application rate and prevent over-application at slower travel speeds.

Over approximately the next 10 years, as the I-93 project progresses toward completion of construction, NHDOT will be replacing and refurbishing the vehicle fleet and equipment used to maintain I-93 due to additional width and lane miles, and due to normal attention. Fleet replacement will include equipment to increase efficiency and effectiveness of operations and thereby allow for reduced applications of deicing materials. Among the equipment improvements that will be considered and pursued are infrared thermometers to enable the operator to adjust salt application based on pavement temperature; and underbody scraper plows which apply more pressure and remove more snow, thereby reducing the quantity of salt required to remove packed snow and ice.

Given the sensitivity of the water quality issues relative to Canobie Lake and Cobbetts Pond, NHDOT will institute the use of salt brine to reduce and mitigate the amount of road salt applied to this section of I-93 and in doing so help minimize and mitigate impacts to water resources. This process involves mixing salt and water to make a brine solution, which is spray-applied to the highway surface at the outset of a winter storm. NHDOT will purchase the necessary equipment and retrofit maintenance vehicles to support this approach. The brine solution involves 20 to 25 percent of the salt typically applied to the highway at the beginning of a storm, concentrates the solution on the highway surface, and more efficiently prevents the build-up of snow and ice bond to the asphalt. It is anticipated that over the course of a winter the use of this brine solution on I-93 could reduce the overall quantity of salt use by 25 to 40 percent.

NHDOT will continue systematically training its maintenance personnel on the importance of appropriate handling and application of road salt, emphasizing that more is not better. Frequent and meaningful training for the crews that maintain I-93

will be conducted in all aspects of winter maintenance and awareness of the environmentally sensitive areas along the corridor. Sensitive areas will be identified and marked to reinforce this for the field crews and raise awareness for the motoring public. The use of private contractors for winter maintenance services on I-93 to supplement NHDOT forces will be minimized as it is felt that use of trained NHDOT personnel and state-owned plow equipment will maximize the efficiency of winter maintenance activities.

Simple reductions in salt applications are not a potential option given the NHDOT's mission to maintain safe travel conditions on these major highways, particularly given the frequent traffic congestion during peak travel times. Reducing the service level to allow lower salt application rate could have other detrimental environmental effects from motor vehicle accidents, increased fuel usage and sand sedimentation issues. In reducing salt applied to the roadway there are related environmental and safety aspects which need to be considered.

As previously discussed, the use of alternative deicers could be considered, but at the present time, is also not a practicable, cost-effective option. Also, these products, especially the agricultural or organic-based deicers, could introduce other contaminants or cause other water quality problems in Canobie Lake. NHDOT has in the past, conducted pilot studies to evaluate the effectiveness of alternative deicers, and will continue to explore the use and practicability of such alternatives for consideration in environmentally sensitive locations.

NHDOT recognizes the sensitivity of streams in the area with elevated chloride levels to additional road salt usage as practicable, associated with a wider highway. NHDOT will pursue the measuring as discussed above to optimize effectiveness and reduce salt usage, as practicable, without jeopardizing service levels or safety. Recognizing that elevated chloride levels are a regional issue, the above maintenance measures are proactive efforts NHDOT will take to reasonably respond to the issue and I-93's contribution. These measures are anticipated to reduce overall future road salt usage by about 25 percent compared to that which would normally be used with existing winter maintenance practices and procedures.

Erosion Control

With respect to the construction activity, under the NPDES Phase II program, any construction activity that involves land disturbance equal to, or greater than, 0.25 ha (1 ac) and less than 2 ha (5 ac), is considered a small construction activity and will require a permit under NPDES Phase II. Land disturbance greater than 2 ha (5 ac) is considered "large" construction activity and will continue to require a permit under NPDES Phase I. On July 1, 2003 the newest Construction General Permit (CGP) became effective for both "large" and "small" construction activities.

All of the requirements of the CGP will be met for each of the project construction contracts including:

- Filing of a Notice of Intent (NOI) by both the "owner" and "operator" with the USEPA that includes general project information and a certification that the activity will not impact Federally-listed threatened or endangered species and documentation that the discharge is consistent with the assumptions and requirements of the applicable USEPA approved or established Total Maximum Daily Load (TMDL(s)).

- Development and implementation of a Storm Water Pollution Prevention Plan (SWPPP); and

- Submission of a Notice of Termination (NOT), when final stabilization of the site has been achieved.

The SWPPP will be prepared in accordance with the conditions and requirements set forth in the CGP and completed prior to submission of the NOI. The goal of the SWPPP is to reduce or eliminate stormwater pollution from construction activity by implementing pollution control Best Management Practices (BMPs) to protect water quality. It will also include designing and implementing erosion and sediment control measures appropriate for the project-specific construction activities and resources. Prior to the commencement of work, the contractor will submit an erosion control and stormwater management plan specific to this project. The plan will be approved by NHDOT and will be implemented, monitored and maintained as noted. Changes to the plan will be made, and documented, as appropriate. During the construction phase, special attention will be given to Canobie Lake and Cobbetts Pond. NHDOT will also stipulate in the contract bid documents that only low or no phosphorous fertilizers can be used during landscaping activities in the watersheds of Canobie Lake and Cobbetts Pond.

Total Maximum Daily Load (TMDL)

Based on the cooperative water quality sampling done to date by NHDOT, NHDES, and USEPA, there are locations in the project area that are near, and could exceed, ambient water quality standards for chloride. Although, the issue has been raised as an element of the I-93 expansion, I-93 is not the primary contributor to elevated chloride levels in many locations. Water quality sampling data indicates that chloride concentrations are currently elevated upstream of I-93 in several streams, which suggests that this is more of a regional issue and will require a regional solution, involving all stakeholders, to meaningfully characterize, address and manage the various sources of chloride. Other chloride sources include deicing activities on other state roads, municipal roads, private roads and commercial parking lots, as well as the discharge from septic systems and water-softening systems. In order to evaluate and potentially manage the various sources of chloride in these watersheds, there is general consensus that a Total Maximum Daily Load (TMDL) study is needed.

Additional water quality sampling for chloride is being conducted jointly by NHDOT, NHDES, and USEPA over the 2003-2004 winter season. The purpose of this

sampling will be to identify and document potentially impaired waters in watersheds in the region and further define the chloride impact area. NHDOT efforts will focus on further characterization of the I-93 contribution. NHDES and USEPA will be focused on framing the regional contributions. The sampling will occur throughout the five major watersheds from Salem to Manchester, at locations that are likely to have elevated chloride levels due to the density of development, roads and parking lots in the tributary watersheds. The sampling will help to better define the area of need for the anticipated TMDL study.

It is anticipated that NHDES will develop a TMDL for chloride sources in the watersheds of any waterbody that is found to not meet the state water quality standards for chloride. The TMDL study will assess, on a regional basis, the relative contribution and effect of the various sources, including I-93, other state roads, municipal roads, private roads and commercial parking lots, septic and water-softening systems as well as salt storage practices by local sources on these impaired waterbodies. Through the TMDL process, salt management actions, source reductions, and recommended salt loadings per source category would be developed to reduce chloride concentrations. This collaborative study will be a tool for better understanding and managing road salt loadings among state, local, and private roadway maintenance activities. NHDOT will participate in this regional TMDL study and work towards implementing, on state highways, the appropriate and practicable road salt management plans that may be developed. It is anticipated that continued monitoring, both pre- and post-construction, of surface waters which receive runoff from the I-93 corridor, that are identified by the TMDL to be of concern, will be necessary.

In summary, the issue of elevated chloride levels will be addressed regionally, in a cooperative manner among NHDOT, NHDES, and USEPA. The issue has been coordinated with the appropriate agencies and steps are being taken to further characterize potentially impaired waterbodies in the region, evaluate sources of chloride loadings, and develop source reduction/management actions to meet water quality standards. NHDOT will continue to actively participate in the monitoring and the TMDL study as it relates to I-93, and will play an active leadership role in the education and community outreach efforts relative to this issue.

Training/Outreach

NHDOT will coordinate and exchange information with local DPW officials regarding new and more efficient ways to store and apply road salt for deicing purposes through the outreach and education efforts as part of the Phase II Storm Water Management Plan, discussed above. NHDOT will also continue to coordinate with NHDES relative to its VLAP Program for monitoring any future changes in chloride concentrations associated with Dinsmore Brook, Cobbetts Pond and the tributaries to Canobie Lake. In association with the TMDL study, raising awareness of the chloride issues, on the best management practices to store and utilize road salt as efficiently as possible, will be important components. Training of municipal and

private maintenance personnel will be a key part in addressing the issue. NHDOT is expected to play a leading role in this education component through the outreach efforts of the NPDES II program, already underway through the regional MS4 groups. NHDOT will share its technical experience and knowledge and provide expert technical assistance to communities where appropriate. Additionally, venues and opportunities for sharing knowledge and experience relative to road salt management and application techniques will be investigated, possibly in conjunction with the Technology Transfer Center at UNH.

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4.4.2 Aquatic Life Impacts

Direct impacts to fisheries resources may result from construction that places fill material in water bodies or waterways and causes the loss of habitat. Fisheries resources may also be indirectly affected by transportation improvements due to increased water runoff. Contaminants from highway runoff may also affect water quality, fish reproduction, or fish mortality, particularly in areas of heavy traffic.

Impacts to aquatic life would occur with both the Three-Lane and Four-Lane Alternatives. The linear extent (feet) of impacts to perennial watercourses are described below. Ephemeral (intermittent) watercourses, constructed drainage swales, and the culverts associated with these drainages were not included in this impact analysis. Highway construction or upgrading existing highways, that cross or abut perennial streams, may result in the following direct and indirect impacts to aquatic habitats:

- Stream channelization;
- Loss of bank structural complexity;
- Loss of stream flow complexity (riffles/pools);
- Shading from bridges or loss of shading from clearing;
- Alteration of water temperature;
- Reduction of water quality from highway runoff impacts; and
- Alteration of stream hydrology.

These impacts may result in the loss of aquatic habitat (direct impacts) and decline in the quality of the habitat for fish and other aquatic organisms (indirect impacts). The analysis of direct impacts, for this phase of the study, is based on the number of perennial stream crossings within each segment of the study area (Table 3.4-1). Impacts occur to existing stream crossings and to streams that are located adjacent to the roadway. Indirect impacts have not been specifically identified for each segment, however new crossings have potentially greater impacts on aquatic habitats than widening an existing bridge or lengthening a culvert.

4.4.2.1 Impact Methodology

Field investigations were conducted during April 2002 to characterize all existing culvert crossings located within the study area. Culvert crossings were classified as a perennial watercourse, intermittent watercourse or drainage swale. Descriptive data collected at each crossing included channel morphology characteristics, culvert characteristics, general riparian vegetation composition, aquatic organisms observed and detailed sketches illustrating channel cross section and locations of any upgradient stormwater sources. Physical characteristics collected at each crossing included temperature, velocity and sampling for benthic invertebrates, field identified to family level. Results of field investigations and personal communications with NHF&GD personnel indicate that although fish are present in most of the perennial watercourses and possibly in portions of some intermittent watercourses, no watercourses in the study area, at least in impacted areas, currently provide high quality fish habitat. The majority of watercourses in the study area exhibit evidence of substantial sedimentation and embeddedness.

In an attempt to quantify impacts to aquatic life in streams and provide some comparison between alternatives and options, the potential impact of each alternative on perennial watercourses was determined by calculating the difference in length of the existing and proposed culvert/bridge crossing for each perennial watercourse affected by construction. First, AutoCAD drafting software was used to determine the existing headwall location for each perennial watercourse. Once the headwall location was identified, the edge of disturbance was overlain onto the mapping. The linear distance from the existing headwall to the proposed edge of disturbance was calculated, defining the linear impact (loss of channel substrate) to each perennial watercourse. Given that in every case the perennial watercourse passes through a culvert under the highway, the impact or direct loss of natural stream bottom habitat is a measurement of the length of culvert extension. As such, the impact to aquatic life is considerably less than if a proposed crossing were completely new.

Subsequent to publication of the DEIS, an analysis was performed to determine whether the existing culverts or other structures carrying streams under the highway posed any impediments to fish passage. For the larger box culverts or bridges, this analysis was done in conjunction with an evaluation of whether wildlife passage could be improved by providing shelves or similar devices in the structures (see Section 4.6.4). Photographs and information collected in the field on each structure (Table 3.4-2) were evaluated for all named and unnamed perennial streams. A total of 18 watercourses passing through culverts with diameters of 48 inches or greater, and 11 with diameters less than 48 inches, were reviewed.

The following criteria were used to evaluate the perennial stream crossings[41]:

- Culvert outlets 'perched' above the natural stream channel causing flow to "drop" from the pipe into a scour pool.
- Culvert inlets set too low, i.e., stream flow "drops" into the pipe.
- Debris buildup or other physical barriers present such as beaver exclusion devices at inlets or outlets.
- Constricted inlet/outlet flows due to undersized culverts.

4.4.2.2 Build Alternatives

Impacts to perennial watercourses associated with each Build Alternative are described below by highway segment. Table 4.4-4 summarizes the impacts to each perennial watercourse in each segment (see also Figure 3.4.1).

Table 4.4-4
Potential Impacts to Aquatic Habitats

Segment	Crossing ID	Existing Length (ft)	Stream Impacts 4-Lane (ft)	Stream Impacts 3-Lane (ft)	Option
A.	77S	45	**771**[1]	759[1]	--
	77S	45	**21**	9	--
	77B	106	**254**	242	--
B.	75N	102	104	92	Reconstruct
	75N	102	**104**	92	Relocate
	75S	64	131	119	Reconstruct
	75S	64	**131**	119	Relocate
C.	70N	81	**81**	69	Diamond
	70N	81	81	69	Loop
	70S	52	**88**	76	Diamond
	70S	52	88	76	Loop
	68N	160	**92**	80	Diamond
	68N	160	92	80	Loop
	68S	146	**78**	66	Diamond
	68S	146	104	92	Loop

41 S. Jackson. University of Massachusetts (Amherst). Paper presented at the New England Society of Wetland Scientists Conference, Worcester, MA, November 14, 2002.

Table 4.4-4 (continued)

Segment	Crossing ID	Existing Length (ft)	Stream Impacts 4-Lane (ft)	Stream Impacts 3-Lane (ft)	Option
	66S	124	**289**	277	Diamond
	66S	124	336	324	Loop
	66D	61	**139**	127	Diamond
	66D	61	139	127	Loop
D.	58N	139	97	85	1 thru 6
	58N	271	**129**	117	7 thru 9
	58S	132	84	72	1 thru 6
	58S	271	**129**	117	7 thru 9
	56N	139	60	48	1 thru 6
	56N	139	**0**	0	7 thru 9
	56S	175	0	0	1 thru 6
	56S	175	**0**	0	7 thru 9
	55C	95	**136**	124	2, 4, 7 thru 9
	55C	95	30	18	1, 3, 5, 6
	51N	132	68	56	1 thru 6
	51N	132	36	24	7 thru 9
	51S	114	**205**	193	1 thru 4, 7, 8
	51S	114	320	308	5, 6
	51S	114	242	230	9
	48S	95	**51**	39	All
	47S	106	**80**	68	All
	47N	126	**80**	68	All
	44S	118	**69**	57	All
	42S	72	**44**	32	All
	42N	130	**14**	2	All
	41N	106	**0**	0	All
	41S	125	**77**	65	All
E.	37N	246	**0**	0	East and West
	37S	158	**29**	17	East
	37S	158	42	30	West
	34N	136	**77**	65	East
	34N	136	80	68	West
	34S	180	**2**	10	East
	34S	180	17	5	West
	33N	72	**121**	109	East
	33N	72	144	132	West

Table 4.4-4 (continued)

Segment	Crossing ID	Existing Length (ft)	Stream Impacts 4-Lane (ft)	Stream Impacts 3-Lane (ft)	Option
	33S	73	**147**	135	East
	33S	73	136	124	West
	27N	230	**123**	111	East
	27N	230	100	88	West
	27S	135	**72**	60	East
	27S	135	121	109	West
	26N	122	**30**	18	East
	26N	122	98	86	West
	26S[2]	113	**2,496**	2,484	East
	26S[2]	113	2,638	2,555	West
	22N	134	**107**	95	East
	22N	134	8	4	West
	22S	112	**63**	51	East
	22S	112	39	27	West
	21N	114	**124**	112	East
	21N	114	57	45	West
	21S	114	**19**	7	East
	21S	114	86	74	West
	19N	112	**28**	16	All
	19S	112	**56**	44	All
F.	18N	120	**107**	95	All
	18S	136	**62**	50	All
	15S	150	**220**	208	All
	11N	117	**71**	59	All
	11S	128	**104**	92	All
	5A	126	**36**	24	All
	4C	147	**0**	0	All
	4E	75	**138**	126	All
	3N	148	**24**	12	All
	3S	110	**0**	0	All
	1A	1,900	**1,000**	1,000	All

1 Includes 750 linear feet of impact to stream channel which will need to be relocated.
2 Includes 2,400 linear feet of impact to stream channel which will be relocated. Culvert at crossing #26 discharges to impacted stream channel.
Bold=Selected Alternative.

Three-Lane Alternative

Habitat characteristics for each of the streams discussed below are taken from Table 3.4-2.

Segment A

Two perennial watercourses, the tributary to Harris Brook (77S) and Policy Brook (77B), are crossed or impacted within this segment.

The Three-Lane Alternative would require realignment of approximately 750 feet of the tributary to Harris Brook (77S). North portions of this watercourse are excavated drainage channel and do not provide fish habitat. The tributary to Harris Brook enters the drainage swale immediately north of Valeska Lane and from this confluence south, functions as a perennial watercourse. Portions north of the confluence function as a drainage swale; standing water was observed in this portion of the swale; no flow was detected and no fish habitat was observed. Therefore, although portions of this channel would be altered, impacts to aquatic life are expected to be minimal because higher quality fish habitat is located in southern portions of this watercourse.

Impacts to Policy Brook total 242 feet and occur at the existing bridge crossing. Channel substrate in the impact area consists of predominantly sand, gravel and small cobbles. Overall, the substrate appeared to be at least 40 percent embedded, decreasing viable spawning and rearing habitat. Further, cover objects and overhanging vegetation were minimal, additionally decreasing habitat viability in this portion of Policy Brook. Although the Spicket River is not impacted, impacts occur to Policy Brook, a tributary to the Spicket River.

Segment B

The tributary to Porcupine Brook (75N, 75S) is the only perennial watercourse crossed within this segment. The substrate consists primarily of sands with some gravel providing marginal habitat for warm water species. Impacts consist of the loss of 211 feet of channel substrate and marginal fish habitat due to culvert extensions for either the relocate or reconstruct options.

Segment C

Three perennial watercourses, Porcupine Brook (70N, 70S), tributary to Porcupine Brook (68,68S), and Policy Brook (66D) are located within this segment. In the vicinity of the stream crossings 70N and 70S, the substrate of Porcupine Brook consists of a cobble and subangular gravel, which provides fish spawning habitat. Substrate of the tributary to Porcupine Brook (68N ,68S) consists largely of sand and that of Policy Brook (66D) consists of boulder and cobble. Impacts at these stream crossings consist of the loss of channel substrate and fish habitat. Impacts from culvert extensions total 695 feet for the diamond option and 768 feet for the loop option.

Segment D

All Exit 3 options (1 through 9) in Segment D for the Three-Lane Alternative would impact seven perennial watercourses. Impacted watercourses include the south and north tributaries to Canobie Lake, tributary to Cobbetts Pond, south and north tributaries to Golden Brook, and north and south tributaries to Flatrock Brook. Channel substrates of these seven perennial watercourses consist of a range of sand, gravel, cobble and boulder, with some reaches providing cold and warm-water species habitat. Impacts consist of loss of channel substrate and loss of fish habitat range from 723 feet to 1,101 feet.

Segment E

Four perennial watercourses would be impacted by both the east and west option. Impacted watercourses include the south tributary to Beaver Brook (not impacted along the northbound lane), Beaver Brook, tributary to Wheeler Pond and tributary to Hoods Pond. Channel substrates of each of the four perennial streams consist of primarily sand and gravel. Three-Lane east option impacts total 3,334 feet; and Three-Lane west option total 3,407 feet. Impact totals include 2,400 feet of impact to the Wheeler Pond tributary due to highway widening and sound wall construction. The stream will be relocated to the west of the sound wall.

Segment F

Five perennial watercourses including the south tributary to Cohas Brook, tributary to Little Cohas Brook (two branches), Cohas Brook, and the north tributary to Cohas Brook would be impacted. Long Pond Brook would not be affected by any of the relocated or reconstruct options. Impacts to the other watercourses are the same for all three options and total 1,666 feet for the Three-Lane Alternative. Potential impacts to Essential Fish Habitat (EFH) occur only at Cohas Brook where there are four crossings: location ID #5A with a concrete box culvert, #4E with a steel beam bridge that has recently been replaced, and #3N and #3S with concrete box culverts. Although a lengthened box culvert with a floor will result in impacts to channel substrate and potential fish habitat, conditions at the existing crossings are already degraded. Channel substrate consists of predominantly coarse sands; little vegetation and undercut banks are present. The dynamic substrate provides minimal habitat for aquatic organisms. (See Section 4.4.2.4.)

Four-Lane Alternative

Habitat characteristics associated with each impacted stream discussed below are the same as described for the Three-Lane Alternative.

Segment A

Both the tributary to Harris Brook and Policy Brook are crossed or impacted within this segment. The Spicket River is not impacted. However, this alternative would

require realignment of approximately 750 feet of the tributary to Harris Brook, a tributary to the Spicket River, and impacts to Policy Brook would total 254 feet.

Segment B

The tributary to Porcupine Brook is the only perennial watercourse crossed within this segment. Impacts from culvert extensions total 235 feet for the reconstruct and relocate options.

Segment C

Three perennial watercourses, Porcupine Brook, tributary to Porcupine Brook, and Policy Brook are located within this segment. Impacts from culvert extensions total 767 feet for the diamond option and 840 feet for the loop option.

Segment D

All Exit 3 options (1 through 9) in Segment D would impact seven perennial watercourses. Impacted watercourses include the south and north tributaries to Canobie Lake, tributary to Cobbetts Pond, south and north tributaries to Golden Brook, and north and south tributaries to Flatrock Brook. Impacts range from 867 feet to 1,257 feet.

Segment E

Four perennial watercourses would be impacted by both the east and west option. Impacted watercourses include the south tributary to Beaver Brook (not impacted along the northbound lane), Beaver Brook, tributary to Wheeler Pond and tributary to Hoods Pond. Impacts from the east option total 3,494 feet; the west option impacts total 3,650 feet. Impact totals include 2,400 feet of impact to the Wheeler Pond tributary due to highway widening and sound wall construction for both options. The tributary stream will be relocated to the west of the sound wall.

Segment F

Five perennial watercourses including the south tributary to Cohas Brook, tributary to Little Cohas Brook (two branches), Cohas Brook, and the north tributary to Cohas Brook would be impacted. Long Pond Brook would not be affected by any of the relocated or reconstruct options. Impacts to the other watercourses are the same for all three options and total 1,762 feet. Potential impacts to Essential Fish Habitat (EFH) occur only at Cohas Brook where there are four crossings: location ID #5A with a concrete box culvert, #4E with a steel beam bridge that has recently been replaced, and #3N and #3S with box culverts. Although a lengthened box culvert with a floor will result in impacts to channel substrate and potential fish habitat, conditions at the existing crossings are already degraded. Channel substrate consists of predominantly coarse sands; little vegetation and undercut banks are present. The dynamic substrate provides minimal habitat for aquatic organisms.

Four-Lane/Three-Lane Combination

A third alternative is the combination of four lanes beginning at the state line and extending north to Exit 3, where the roadway would narrow to three lanes northward to the I-93/I-293 split located in Manchester. Since the same perennial watercourses are affected by Three-Lane and Four-Lane Alternatives, the Four-Lane/Three-Lane Combination would affect the same perennial watercourses as either alternative constructed separately. The Three-Lane Alternative impacts are slightly lower, due to the narrower cross section of the finished roadway.

Sound Walls

Additional impacts to perennial watercourses or aquatic habitat beyond those already described (i.e., the tributary to Wheeler Pond) will not occur due to construction of sound walls. These have been considered as part of the overall Selected Alternative.

Park-and-Rides

The new park-and-ride facility at Exit 5 will require culverting 800 feet of the tributary to Little Cohas Brook (14B). Approximately 250 feet of this stream is already culverted as it flows along the eastern edge of Cycle World.

4.4.2.3 No-Build Alternative

Under the No-Build Alternative, current conditions impacting aquatic life, including sedimentation and road salt transport, will continue. In addition, the present limitations and problems identified with existing culverts will be perpetuated (see Sec. 4.4.2.4).

4.4.2.4 Essential Fish Habitat Assessment

Merrimack River and its tributaries are designated EFH for Atlantic Salmon (eggs, larvae, juveniles, and adults). Two tributary streams to the Merrimack River, but not the river itself, are within the project corridor: Cohas Brook and Little Cohas Brook. Project effects on each are summarized below:

- **Cohas Brook** – two concrete box culverts and one bridge will be widened or replaced in-kind (Locations #5A, #3N, and #4E, see **Figure 3.4-1**). Degraded conditions with coarse sands exist at the box culvert locations where the stream bottom will be impacted with in-kind replacement of the structures. Since the bridge at #4E was recently replaced and both stream banks rip-rapped with stone, extending the abutments for the additional minor widening is not

expected to impact the stream bottom or any natural bank. BMPs will be used to prevent runoff impacts during construction.

- **Little Cohas Brook** – no direct impact because brook is distant from highway. Only tributaries to Little Cohas Brook are affected by the project. BMPs will be used to prevent any downstream runoff impacts during construction.

NHDOT and FHWA have coordinated with NMFS concerning potential impacts on EFH for Atlantic salmon. Completion of the EFH Assessment Worksheet and preliminary review by NMFS indicate that the Selected Alternative will have an "adverse effect" on EFH that is "not substantial". Documentation supporting this conclusion will be provided to NMFS to satisfy that agency's consultation requirements.

4.4.2.5 Highway Crossings and Habitat Quality/Fish Passage

Problems at existing highway crossings with either stream habitat quality or impediments to fish passage are summarized in Table 4.4.5. These problems will continue under the No Build condition but will be evaluated and addressed under the Selected Action. The recommended improvements relative to wildlife passage are discussed in Section 4.6.4.5.

4.4.2.6 Mitigation

Best Management Practices (BMPs) for erosion and sedimentation control will be utilized during construction to protect all aquatic resources, including EFH in Cohas Brook, Little Cohas Brook and the Spicket River. These BMPs will effectively treat stormwater runoff and control overland flow velocities. Where overhanging trees and brush are removed at culvert entrances, and such trees and brush appear to shade fish habitat, landscaping of a similar type will be provided. Lastly, where culvert conditions have been identified to enhance passage of fish and wildlife, these will be evaluated in final design and implemented where practicable.

Table 4.4-5
Highway Crossings with Habitat Quality or Fish Passage Issues

Watercourse Name	Location ID # (Table 3.4-2)	Fish Habitat Present	Limitations/Problems	Potential Improvements[1]
Cohas Brook	3N, 3S, 4E, 5A	Yes	Stream channel heavily embedded with silt, sand, gravel; lacking cover and channel complexity for fish. No wildlife passage at 3N, 3S and 5A.	Stream restoration (channel and bank) opportunity; construct shelves within box culverts
Tributary to Hoods Pond	19N, 19S	Yes	In-stream debris and sediment west of inlet, existing culvert may be backing up material	Restore stream channel conditions similar to those downstream of culvert; replace pipe with open bottom structure with sub-angular gravel, and stones
Tributary to Wheeler Pond	26S	Yes	Culvert appears to be set too low; fence posts obstructing outlet to stream	Raise culvert to allow more flow; remove obstructions
Tributary to Wheeler Pond	27N/27S	Yes	Culvert inlet appears to back-up flow at headwall; point bar/ fill area at headwall and northern bank largely vegetated with invasive species	Raise culvert to allow more flow; remove obstructions; restore native vegetation to northern stream bank
Tributary to Beaver Brook (outflow of Wheeler Pond)	32B	Yes	Arch box culvert with artificial impoundment (pipes and wood)	Opportunity for "dam" removal to re-establish stream connectivity
Beaver Brook	33N, 33S	Yes	No wildlife crossing structures beneath box culverts	Construct shelf
North Tributary to Beaver Brook	34N, 34S	Yes	Perched culvert in marginal fish habitat	Embed new culvert to eliminate flow drop
South Tributary to Beaver Brook	37N, 37S	Yes	Flow restricted by substandard culvert size	Increase size of new properly embedded pipe or open bottom structure
North Tributary to Flat Rock Brook	41N, 41S	No	Culvert set too low, heavy sedimentation may impede drainage through area and reduces fish habitat	Raise culvert invert to improve flow through system; stream channel restoration and properly embedded culvert could encourage fish passage
Tributary to Cobbetts Pond	51N, 51S	No	Perched culvert	Properly embedded culvert could encourage fish passage
North Tributary to Canobie Lake	56N, 56S	No	Perched culvert	Properly embedded culvert could encourage fish passage
Policy Brook	66D	Yes	Perched culvert prevents fish passage	Properly embedded or open bottom structure could help re-establish fish spawning habitat of stream
Tributary to Porcupine Brook	66S	Yes	Channel heavily embedded with road sand, silt and debris	Stream restoration (channel and bank) opportunity
Tributary to Porcupine Brook	68N, 68S	No	Degraded stream conditions, channel heavily embedded with road sand, silt and debris	Stream restoration (channel and bank) opportunity could help establish fish habitat
Porcupine Brook	70N, 70S	Yes	No wildlife crossing provided within existing box culvert	Enlarge box culvert, add shelf for wildlife crossing
Policy Brook	77B	Yes	No wildlife crossing provided within CMPs	Replace with box culvert containing a shelf or new bridge

1 Potential improvements to be evaluated as part of the Final Design.

■

4.4.3 Groundwater Resources

4.4.3.1 Introduction

The following section presents an analysis of the potential impacts on groundwater resources in the project area as a result of the proposed project. The principal groundwater resources include stratified-drift aquifers and public wells that are located within or adjacent to the project area. As described in Section 3.4.2.1, there are two principal stratified-drift aquifers located at the southern and northern ends of the project area. Neither of these two stratified-drift aquifers are currently being used for drinking water supply purposes. The major impacts of concern relate to the potential reduction in recharge to the aquifer due to increased impervious area and the increased risk of contamination due to various pollutants from land-use activities including the use of road salt for deicing purposes. The analyses described below includes a comparison of existing and proposed roadway area within stratified-drift deposits as well as an evaluation of the potential long-term average annual sodium and chloride concentrations in groundwater at the downgradient edge of the right-of-way.

Public wells in the study area represent the other principal groundwater resource of concern. As described in Section 3.4.2.2, NHDES has several categories of community and non-community public wells and considers roadways and transportation facilities as moderate contamination risks and has developed a guidance document of recommended groundwater protection measures for new or improved roadways that may be within the Wellhead Protection Area (WHPA) or within a certain distance from certain types of public wells. This document provides the basis for assessing groundwater protection needs as it relates to the proposed project and is described further below.

Subsequent to publication of the DEIS, additional sodium and chloride data was retrieved from several of the active public wells in the project corridor. This additional data is presented and incorporated into the impact analyses described below. The sodium and chloride data were used to assess whether any of the public wells are currently being affected by road salt use on the highway, as well as identify those wells that may be most at risk for future impacts under the proposed build conditions.

4.4.3.2 Groundwater Impact Analysis Methodology

Stratified-Drift Aquifers

The amount of I-93 roadway area traversing through identified stratified-drift aquifer areas was estimated for each of the project alternatives using the preliminary design plans (**Figure 3.4-2**). Based on the estimated amount of roadway area within

each of the stratified-drift aquifers, a general assessment of the potential effect on groundwater recharge as well as the existing or future use of the aquifer was conducted while considering the inherent characteristics of the aquifer, the availability of an existing municipal water supply system and the existing land use conditions within the aquifer area. The presence of roadway areas in stratified-drift aquifers does not necessarily imply that impacts to groundwater quality will occur such that the stratified-drift aquifers will no longer be viable for existing or future water supplies. In fact, throughout New Hampshire, it is not uncommon for roadways and other types of development to be located in the same sand and gravel aquifer that is being used to supply a community well for drinking water purposes.

Potential Sodium and Chloride Impacts from Deicing Activities

Sodium and chloride as components of road salt, which is used to maintain safe travel conditions during the winter season, can pose a potential threat to groundwater used for drinking water because of the high solubility and mobility of sodium and chloride in water and the potential adverse effects on drinking water associated with taste. Currently, NHDES has a secondary drinking water standard of 250 mg/l for chloride and sodium to avoid problems with taste.

The amount of sodium and chloride that potentially enters the groundwater depends on the application rate, the amount of roadway treated and the amount of highway runoff that infiltrates into the soil carrying the sodium and chloride ions. The resulting concentration in groundwater depends on the distance from the roadway, the amount of dilution provided by the groundwater flow and the additional recharge received along the travel path. Using a mass-balance approach, the average annual sodium and chloride concentrations at the downgradient edge of the right-of-way were estimated while accounting for the various hydrogeologic conditions under the No-Build and the proposed Four-Lane Alternative. The Four-Lane Alternative represents the worst case of any of the Build Alternatives.

An infiltration zone was established which corresponds to the distance between the downgradient edge of right-of-way and point 50 feet above the upgradient edge of pavement. On average, the right-of-way width was estimated to be 300 and 400 feet for the existing and proposed build conditions and this includes an average median width of 100 feet, which varies substantially and is much larger in many locations. A worst-case analysis was conducted by assuming all of the applied sodium and chloride infiltrated into the groundwater beneath the infiltration zone with the average annual recharge. In reality, depending on the underlying soil types and drainage infrastructure, much of the applied road salt may be conveyed by surface runoff and end up in nearby surface waters.

The average annual application for road salt was based on an estimated annual rate of 22.8 tons per lane-mile, which is considered the average annual rate used on the I-93 roadway segment from Salem to Manchester for the last 10 years (NHDOT - District 5 Highway Maintenance Engineer, 2002). It was also assumed that chloride

and sodium comprises 61 and 31 percent of the road salt, respectively. Each mile of I-93 was assumed to consist of 4 and 8 lane-miles under the No-Build and the Four-Lane Alternative, respectively. Again, the analysis focuses on the Four-Lane Alternative, since it represents the worst-case condition.

The average annual recharge entering the infiltration zone was based on the average annual precipitation less evapo-transpiration or approximately 19 inches (Stekl and Flanagan, 1992). The road salt entering the groundwater below the infiltration zone was then diluted by the background groundwater flow passing beneath the infiltration zone. The background sodium and chloride concentrations in groundwater were assumed to be 10 and 19.5 mg/l, respectively, based on the median background levels measured in thirty different monitoring wells located throughout southeastern New Hampshire (Flanagan and Stekl 1992). The groundwater flow rates (acre-feet/year) were based on an estimated mixing depth of 10 feet and estimated groundwater velocities of 10.0, 4.2 and 1.25 feet/day for coarse-grain, fine-grain stratified-drift and glacial till deposits, respectively. These velocities are based on typical permeability, slope and porosity data provided in the USGS reports (Flanagan and Stekl, 1992). Additional dilution that would occur beyond downgradient edge of the right-of-way was not included in this analysis.

For the public wells in the project corridor, the assessment of potential impacts associated with road salt use was based on the existing sodium and chloride data retrieved for each well. The data was either retrieved from the NHDES Drinking Water Protection Program data base or through recent sampling efforts as part of the road salt sampling study conducted by NHDOT from December 2002 through May 2003.

Encroachment on Wellhead Protection Areas for Community Public Wells

An analysis was conducted to determine whether the proposed roadway improvements under the proposed alternatives would encroach upon the Wellhead Protection Areas (WHPAs) associated with the public wells that are within, or adjacent to, the project area as identified by NHDES. NHDES has developed a list of recommended groundwater protection measures or Best Management Practices (BMPs) for new or re-constructed roadways that are within the WHPA of a public water supply well (NHDES 1995). As shown in Table 4.4-6, there are four (4) escalating levels of protection with various recommended BMPs to select from depending upon on the size of well (i.e., production capacity) and distance from the roadway. The BMPs are geared toward protecting the well from contaminants potentially contained in highway runoff as well as from vehicular related spills and include both structural and non-structural measures. The structural measures may include lined grassed swales, and lined snow storage areas (i.e., median and

Table 4.4-6
NHDES Recommended Best Management Practices for Groundwater Protection Associated with New or Improved Roadway Construction

	Applicability	Recommended measures
Level 1	For all new and improved roadway areas.	Use grassed swales and/or other appropriate stormwater treatment BMPs to treat runoff from roadways, wherever possible.
Level 2	Any new or improved roadway section that is within the following areas: • Wellhead protection area for community (C) or non-community, non-transient (P) public well; • Locally designated groundwater protection areas; • GA1 designated areas (watersheds or recharge areas to existing or future water supplies) (Exceptions: see below[1])	1) Appropriate storm water treatment BMPs. (i.e., grassed swales, detention ponds, etc.) 2) Non-structural measures (Provide site-specific drainage information to local and state emergency spill response officials).
Level 3	Any new or improved roadway that is: • Within 1000 feet of a large (≥ 57,600 god) C or P public well • Within 500 feet of a small (<57,600 god) C or P well (Exceptions: see below[1])	1) Lined grassed swales. 2) Lined snow storage areas (i.e., shoulder and median areas). 3) Divert runoff out of the area to the extent possible. 4) Higher guard rail to minimize the potential for truck rollovers. 5) Reduce salt applications as feasible.
Level 4	Any new or improved roadway that is: • Within 400 feet of a large (≥ 57,600 god) C or P public well • Within 200 feet of a small (<57,600 gpd) C or P well	1) Closed drainage system discharging outside the Level 4 area. 2) Higher guard rail to minimize the potential for truck rollovers. 3) Non-structural measures (Provide site-specific drainage information to local and state emergency spill response officials).

1 Exceptions: Recommended measures for a lower level may be used if one of the following conditions apply: (1) the area is also not within a Level 3 or 4 area; (2) there is a competent impermeable layer between the well's screened interval and the road surface or: (3) the bottom of the well is above the elevation of the highway so that the groundwater flow direction is away from the well, or (4) the WHPA of an overburden well does not include the highway or its drainage system.

gpd= gallons per day

shoulder areas), runoff diversion through closed drainage and raised guardrails to minimize vehicle rollovers. The non-structural measures include providing site-specific drainage information to local hazardous materials response teams. These recommended BMPs were intended to apply only to community and non-transient, non-community public wells. Several site-specific factors should also be considered in selecting the most appropriate protection measures. These factors include whether the aquifer supplying the well is confined and separated from the highway by a competent impermeable layer or the bottom of the well is above the elevation of the highway such that the flow direction is away from the well.

As defined by NHDES, community wells include wells that involve 15 or more service connections or serve more than 25 people of the same people 365 days a year. These are wells associated with residential properties such as single-family homes, multi-family units including condominiums and apartments and mobile home parks.

The public well locations and associated Wellhead Protection Area (WHPA) information was supplied by NHDES. Although it is not a public well, the Canobie Lake watershed was also included in this analysis, since it is classified as a GA1 zone under the WHPA regulations, which is a recharge or watershed area to a public water supply. The distance to each of the individual wells was determined using the 1 inch equals 400 feet scale preliminary design plans for the Four-Lane Alternative.

4.4.3.3 Groundwater Impact Analysis Results

Stratified-Drift Aquifers

Table 4.4-7 presents a comparison of the estimated amount of I-93 roadway area within the two primary stratified-drift aquifers in the project area under the various project alternatives (as shown on **Figure 3.4-2**). The roadway area under the Build Alternatives includes the pavement area from both the existing and the proposed roadway area. In the southern stratified-drift aquifer, which extends from the state border north to about midway between Exits 1 and 2, the amount of roadway area associated with the project under the proposed alternatives will increase from about 44.0 acres to 75.0 acres under the Three-Lane Alternative and to about 77.5 acres with the Four-Lane Alternative. There is relatively little difference between the two alternatives south of Exit 1 which accounts for the minimal difference in the estimated pavement area within the aquifer. In the northern stratified-drift aquifer, the amount of I-93 roadway area is estimated to increase by about 40.0 and 50.0 acres under the Three-Lane Alternative and Four-Lane Alternative, respectively. The proposed park-and-ride facilities at Exits 2 and 3 would be outside these stratified-drift areas. However, the proposed location of the Exit 5 park-and-ride facility contributes 5.5 acres of impervious area. In general, for each of the stratified-drift aquifers, which are estimated to be over 5,000 acres in size, the increase in roadway area within the stratified drift area associated with the project is estimated to be about 55 to 75 acres, which represents a small percentage of the overall aquifer size.

Most of the southern stratified-drift aquifer is composed of finer-grained material and has shallow depths of less than 20 feet. In addition, a considerable amount of the land area is already extensively developed with commercial properties along Rockingham Park Boulevard, South Policy Street and NH 28. As described in Section 3.4, the Town of Salem has two production wells located about 3,000 feet

Table 4.4-7
Comparison of I-93 Roadway Area Crossing the Two Stratified-Drift Aquifers in the Project Area under the No-Build and the Build Alternatives

Total I-93 Roadway Area (acres) Overlying Each Stratified-Drift Aquifer							
Southern Aquifer Roadway Segment[1]		**A**	**B**		**C**		
			Exit 1		**Exit 2**		
Alternative	**Transmissivity (ft^2/d)[2]**		**Reconstr.**	**Relocate**	**Loop**	**Diamond**	**Total Acres[3]**
No-Build	<1000	13.3	21.3		7.2		41.8
	1000-2000	1.0	1.1		--		2.1
3-Lane	<1000	21.8	32.0	36.1	13.4	13.4	71.3
	1000-2000	1.8	2.0	2.1	--	--	3.9
4-Lane	<1000	22.6	32.5	36.6	14.4	14.4	73.6
	1000-2000	1.8	2.0	2.1	--	--	3.9
Northern Aquifer Roadway Segment[1]		**E**			**F**		
		Exit 4			**Exit 5[4]**		
Alternative	**Transmissivity (ft^2/d)[2]**	**East**	**West**	**Relocate NH 28**	**Recon NH 28**	**Reloc NB NH 28**	**Total Acres[3]**
No-Build	<1000	26.4			8.6		35.0
	1000-2000	3.9			--		3.9
3-Lane	<1000	49.0	47.8	23.0	22.0	22.8	72.0
	1000-2000	5.9	6.0	--	--	--	6.0
4-Lane	<1000	57.2	56.0	24.3	24.8	25.2	82.5
	1000-2000	6.9	6.8	--	--	--	6.9

Notes:
1 The entire project area consists of Roadway Segments A through F – There are no stratified –drift aquifers in Roadway Segment D.
2 Transmissivity data is based on the USGS Hydrological Investigations (Flanagan and Stekl, 1992). The maximum transmissivity in the project area was 2000 sq. ft./ day.
3 Total acres include the maximum total for all alternatives and the existing roadway area.
4 Increases in roadway areas for Exit 5 are related to the new location of the Park-and-Ride Facility.
-- Indicates no impacts for this transmissivity area.

west of the I-93 roadway, but they have not been used for nearly two decades because of a contamination problem. This aquifer is not considered to be highly favorable for use as a future water supply source given the extent of the existing development, the low production potential and existing contamination problems within this aquifer area. Most of the residences and commercial properties throughout this area are serviced by the Salem municipal water system.

Nearly all of the existing and proposed roadway area is within the low transmissivity portions of the aquifers. Under all of the alternatives and design options, less than 10.8 acres of roadway area is estimated to be within the medium transmissivity portions of either aquifer (i.e., 1000-2000 ft^2/day). One of the most productive portions of the northern aquifer is located within the Beaver Brook river valley just east or upgradient of the I-93 roadway in the West Derry area. The Town of Derry at

one time used a production well located in this area, but has not used it since the early 1980's, when they tied into the Manchester Water Works system, which now supplies water for most of the properties along NH 102 and 28.

The comparison of roadway area within stratified-drift aquifers also shows that there are relatively minor differences between the various design options for the interchanges. For Exit 1, the difference between the proposed reconstruction and relocation options would be about 4.1 acres for both the Three-Lane and Four-Lane Alternatives with the relocation option having the higher amount. For Exit 2, there is essentially no difference in the amount of roadway area in the stratified-drift aquifer in comparing the Loop option with the Diamond option. For Exit 3, there are no impacts to the northern or southern aquifers as they lie north of, and south of, the interchange area.

In review of the two Exit 4 design options, the westerly relocation option would result in slightly less roadway area (approximately 1.3 acres less) in the stratified-drift aquifer as compared to the easterly relocation option with either the Three-Lane or Four-Lane Alternatives. For the Exit 5 interchange, the difference in estimated roadway area between the three different design options is less than 1.0 acre with either the Three–Lane or Four-Lane Alternative. The relocation of NH 28 would have the highest amount. Again, given the overall size of the stratified-drift aquifer, the extent of the low transmissivity and the limited overall use of the aquifer for water supply, the expected increase in roadway area under the various project alternatives is not expected to result in any measurable adverse impacts to the aquifer. The potential impacts on stratified-drift aquifers associated with increased deicing activities are presented in the next section.

Results of the Sodium and Chloride Analysis on Stratified Drift Aquifers

Table 4.4-8 presents the estimated average annual sodium and chloride concentrations in groundwater at the downgradient edge of the right-of-way for the several types of geologic deposits that exist in the study area under the No-Build and Four-Lane Alternative. The results show that even with the proposed doubling of roadway lane-miles under the Four-Lane Alternative, the average annual sodium and chloride concentrations in groundwater at the edge of the right-of-way along the entire length of roadway are projected to be well below the 250 mg/l secondary drinking water standard for sodium and chloride.

The lowest average annual sodium and chloride concentrations are expected to be in the stratified-drift deposits, because of the greater groundwater flow rates and available dilution. Slightly higher concentrations projected for the fine-grained deposits are due to the lower permeability rates (i.e., 25 and 50 feet/day for the fine-grain and coarse-grain material, respectively), which translates into less dilution from background groundwater flow. In the stratified-drift deposits, the projected sodium and chloride concentrations are roughly 25 to 50 percent higher under the Four-Lane

Table 4.4-8
Estimated Average Annual Sodium and Chloride Concentrations in Groundwater at the Edge of Right-of-Way within Stratified-Drift and Till Deposits under the No-Build and Four-Lane Alternative

	No-Build Alternative	Four-lane Alternative
Stratified-Drift		
Coarse-Grained		
Sodium (mg/l)	16.6[1]	22.3[1]
Chloride (mg/l)	29.4	38.6
Fine-Grained		
Sodium (mg/l)	24.4	37.9
Chloride (mg/l)	41.7	62.7
Till Deposits		
Sodium (mg/l)	53.0	93.3
Chloride (mg/l)	86.1	149.0

[1] The estimated concentrations were modified from the DEIS due to the revised average annual road salt application rate.

Alternative, depending on the material (Table 4.4-8). The roadway areas that are considered to be within stratified-drift deposits include most of the roadway south of Exit 2 and another section starting just south of Exit 4 and continuing northward to Stonehenge Road, but excluding the Exit 4-Interchange area itself. Much of the Exit 5 roadway area and another short section just north of the Londonderry/Manchester town line are also considered to overlay stratified-drift deposits.

As expected, the projected sodium and chloride concentrations are higher in the till deposits relative to the stratified-drift deposits due to the lower ground water velocities and less available dilution in the till deposits. However, both the future sodium and chloride concentrations are well below the 250 mg/l secondary drinking water standard. It is important to note that in calculating the existing and future concentrations, it was assumed that all of the applied road salt and associated sodium and chloride would infiltrate into the groundwater. In till deposits, in particular, because of the lower infiltration potential, a fair amount of the applied road salt will be conveyed by runoff to surface waters, which would result in lower groundwater concentrations. To be conservative, the surface water impact analysis assumed that all of the applied road salt was conveyed to the surface water resources.

Much of the middle portion of the project area, located between Exits 2 and 4, is underlain by till deposits. Even though the average annual sodium and chloride concentrations are not expected to exceed 250 mg/l beyond the project right-of-way in till deposits, the area that would be considered most susceptible to road salt

impacts is the area located downgradient from Exit 3. The residential and commercial properties in this area are all served by community or private wells located in the area. In contrast, the commercial and residential properties located adjacent to Exits 2 and 4 are primarily serviced by municipal water supply systems and represent less of a concern with respect to road salt impacts.

Encroachment on Wellhead Protection Areas (WHPAs) Associated with Public Wells

Table 4.4-9 presents the relevant public wells, their associated WHPA radius and the estimated distance from the new roadway to each well and the amount of roadway within the WHPA limits. The public well locations and associated WHPA radius are based on the public well location maps provided by NHDES for the project area (April 3, 2002). The estimated distances from the roadway are based on the No-Build and the Four-Lane Alternatives to represent a worst-case analysis. The public wells listed as inactive by NHDES were not included in this analysis.

Of the twelve active public wells in the project area, seven have established WHPAs with a protective radius ranging from 1200 to 4000 feet. The wells that have established WHPAs correspond to four community wells servicing residential properties and three non-community, non-transient wells serving businesses or day care facilities. NHDES as a general policy has not established WHPAs for non-community, transient wells. With respect to the estimated distance between roadway and the identified public wells, as many as five wells located near the Exit 3 Interchange, would have greater separation distance from the roadway under the proposed Four-Lane Alternative based on the selected design option and the resulting roadway alignment through the interchange area. The largest increase could occur with the Pennichuck Water Works wells where the northbound lanes would be shifted from about 400 feet to 1150 feet away from the wells under the proposed "tight shift" alignment, which is included in the Selected Alternative. This would result in a positive impact to the wells allowing for greater separation distance and added protection to the wells with regard to accidental spills. Without the "tight-shift" option, the new roadway would remain about 400 to 500 feet from the Pennichuck community wells.

With the proposed Exit 3 improvements, three other wells could also be further away from the newly constructed I-93 mainline and associated ramps. The proposed southbound on-ramp would be an additional 300 to 500 feet away from the well that serves the Castleton facility and with the "tight-shift" option (Selected Alternative) the I-93 mainline could be about 900 feet away instead of about 600 feet from the facility under existing conditions. With any of the Exit 3 Interchange design options, the wells serving the Searles Castle property well and the Semiconductor Circuits facility would also be several hundred feet further away from the new I-93 mainline location. However, since both wells are already (and will continue to be) upgradient of the I-93 roadway, the added distance would represent a limited benefit.

Table 4.4-9
Estimated Amount of WHPA Encroachment for Public Water Supply Wells Located Within the Project Area

				No-Action		Build (4-Lane)	
Well No.[1]	Facility Name	WHPA Radius[2]	System Type[3]	Distance From Roadway (feet)	Roadway in WHPA (lane-miles)	Distance From Roadway (feet)	Roadway in WHPA (lane-miles)
2	Pennichuck Water Works (2 wells) West Shore Rd.	4000 ft	C	400	5.8	1150	10.8
4	Semiconductor Circuits, Inc. NH 111	1200 ft	P	1900	None	2700	None
5	Sisters of Mercy –Searles Castle Property 21 Searles Road	2000 ft	C	1500 upgradient	2.10	2100 upgradient	1.90
6	Citizens Bank 115 Indian Rock Rd.	NA	N	300	NA	1200 100 (NH 111)	NA
7	Plaza 93-Dunkin Donuts NH 111	NA	N	400	NA	would be acquired	NA
8	Castleton Banquet Facility 92 Indian Rock Rd	NA	N	300	NA	800	NA
9	Early Years Kindergarten 71 Indian Rock Rd.	1300 ft	P	1800 100 (NH 111)	0.94	1800 180 (NH 111)	1.88
10	McCauley Common Condos 37 Searles Rd.	2000 ft	C	1200 upgradient	2.34	1600 upgradient	4.68
11	Taylors Country Day Care 125 North Lowell Road	1300 ft	P	800	1.70	760	3.4
12	Taylors Ballroom 122 North Lowell Road	NA	N	1000	NA	960	NA
13	Go-Go Mart 132 North Lowell Road	NA	N	1000	NA	960	NA
14	Boumil Grove Condos 1 Charleston Avenue	1500 ft	C	500	1.60	460	3.2

1 Well No. represents the map numbers presented in **Figure 3.4-2**.
2 WHPA radius as measured from NHDES public well location maps (April 3, 2002).
3 System type refers to:
C=Community well serving residential customers or buildings (i.e., homes, condominiums, mobile homes, etc.)
P=Non-community, non-transient supply well serving 25 or more of the same people at least 180 days of the year (i.e., businesses, day-care, schools, etc.).
N=Non-community, transient supply wells serving 25 or more different people at least 60 days of the year (i.e., restaurants, motels, campgrounds, etc.).
NA=Not applicable for non-community, transient wells or inactive well systems.

Under any of the proposed Exit 3 Interchange improvements, the Plaza 93 facility is proposed to be acquired due to the proposed shifting of the roadway and, therefore,

this public well would be eliminated. In contrast to previous assumptions, the public well serving the Yankee Trader property (Citizens Bank) would remain. However, the property owner has indicated that the well is not used for drinking water purposes and bottled water is provided for potable water use.

The proposed options for reconstructing or relocating the section of NH 111, west of the Exit 3 interchange, will have differing effects on the distance and the juxtaposition of the new roadway relative to the public well serving the Early Years Kindergarten located on NH 111 on Windham. Currently, the NH 111 roadway is about 150 feet south of the Kindergarten well, but is considered down-gradient of the facility. The groundwater is assumed to flow in a north to south direction towards Cobbetts Pond. With the reconstruction option, the new NH 111 roadway section would be slightly closer, but would remain downgradient of the facility. Under the relocation option, the new roadway would be located about 150 feet north of the facility, essentially upgradient of the facility. This upgradient location may pose a greater risk to the well even though the new roadway would be about the same distance from the well. Neither design option would substantially affect the distance from the I-93 roadway, which will still be about 2000 feet away and outside the 1200 feet WHPA radius.

For the remaining five public wells that are located north of the Exit 3 Interchange, the proposed highway footprint, under the proposed Four-Lane Alternative, will be slightly closer to each well by about 40 feet. This accounts for the additional pavement width associated with the two additional travel lanes plus the additional shoulder width. The community well serving the Boumil Grove Condominiums in Londonderry (just south of Exit 4) will be closest to the proposed roadway at an estimated distance of 460 feet as compared to 500 feet under existing conditions.

In terms of the total amount of I-93 roadway area (lane-miles) within the WHPA, the community wells owned by Pennichuck Water Company will have largest amount with an estimated 10.8 lane-miles under the proposed Four-Lane Alternative as compared to 5.8 lane-miles under the No-Build Alternative. Although the number of lanes will double, the increase in roadway area in the WHPA is not quite double because several hundred feet of the roadway will be shifted out of the WHPA at both the northerly and southerly limits of the WHPA. The community well servicing the McCauley Common Condos has the second largest amount of the roadway area within the WHPA with an estimated 2.3 and 4.7 lane-miles in the WHPA under the No-Build and Four-Lane Alternative, respectively. However, this well is located upgradient of the I-93 roadway location similar to the well servicing the Searles Castle property. The wells that supply both Taylors Country Day Care and the Boumil Grove Condos have the next largest and similar amounts of I-93 roadway area in the WHPA with 1.6 to 1.7 lane-miles under the No-Build Alternative and about 3.2 to 3.5 lane-miles under the Four-Lane Alternative. The only other public well with an established WHPA relates to the Early Years Kindergarten Facility, which has no I-93 roadway area in its WHPA, but has about 0.9 and 1.8 lane–miles of NH 111 roadway area under the No-Action and proposed Four-Lane Alternative, respectively.

According to the NHDES Recommendations for Groundwater Protection Measures for New and Improved Roadways, there are two community and two non-community, non-transient wells that may warrant higher than Level 1 protection measures (see Table 4.4-6). The well serving the Boumil Grove Condominiums in Londonderry may warrant Level 3 protection measures since this small community well will be within 500 feet of the proposed new or reconstructed roadway, regardless of the proposed alternative. The well is down-gradient of the highway and is located in a sand and gravel aquifer with no known impermeable layers. As an alternative, it may be possible to connect to the municipal water system since a new water main appears to have been recently installed within 500 feet of the condominium location.

With the "tight-shift" option (Selected Alternative) for the Exit 3 Interchange, only Level 2 groundwater protection measures would be recommended for the community wells owned by the Pennichuck Water Company, based on the NHDES guidance criteria. This design option would relocate the I-93 mainline so that it is approximately 1,000 feet away from the wells as opposed to the current distance of about 400 to 500 feet. Otherwise, Level 3 measures would be recommended, since the reconstructed roadway would be within 500 feet of the wells. Due to the large WHPA radius associated with the Pennichuck wells (i.e., 4,000 feet), the added costs associated with the Level 3 structural measures would be substantial since it would involve upwards of 8,000 feet of roadway, as well as the Exit 3 Interchange area. The proposed park-and-ride facility at Exit 3 will also be within the WHPA of the Pennichuck Wells. It is worth mentioning, however, that the proposed diamond ramp configuration with increased de-acceleration distances, particularly with the southbound off-ramp, is expected to substantially reduce the potential for truck rollovers and any associated spills, relative to the existing loop-ramp configuration.

The primary differences between Level 2 and Level 3 protection measures is that under Level 3, NHDES recommends the use of impermeable materials in the lining of drainage swales and median areas to reduce the infiltration of sodium and chloride into groundwater, the diversion of runoff outside of the WHPA to the extent feasible, and the use of raised guard rails, where appropriate, to reduce the potential for truck rollovers and related spills, as well as possibly reducing road salt applications. As previously discussed, these are in addition to Level 2 measures, which include the use of appropriate stormwater treatment measures and coordination with the local hazardous materials spill response personnel to insure they have sufficient site drainage information with respect to actual well location and likely spill migration patterns in the event of a vehicle-related spill.

The potential level of groundwater protection measures recommended for the well serving the Early Years Kindergarten located along NH 111 may depend on whether the NH 111 section is reconstructed or relocated. Currently, NH 111 is located about 150 feet down-gradient of this facility. Under the reconstruction alternative, the roadway would be slightly closer, but still down-gradient of the well, which would suggest Level 2 measures may be sufficient. With the relocation alternative (Selected

Alternative), the new roadway would be located about 150 feet from the facility but, more importantly, upgradient of the facility. This may trigger the need for added protection measures consistent with the Level 3 measures. The WHPA radius for this well is much smaller and, therefore, involves less roadway area. It appears that any opportunity to divert runoff outside of the WHPA, to the extent feasible, would be most appropriate along this roadway section.

Level 2 measures would also be considered appropriate for the roadway area within the WHPA associated with the Taylors Country Day Care facility near Windham Depot area. Level 1 protection measures, which consist of implementing appropriate stormwater treatment measures, will be used for all other wells in the project area. NHDOT also maintains a Well Replacement Program that will be utilized to address any future reported adverse impact to public and private wells. Additional details of this Program are discussed in the Mitigation section. Except at Exit 3, as mentioned above, none of the proposed park-and-ride facilities will be in the WHPAs of the identified public wells.

Sodium and Chloride Impact Analysis for Public Wells

The existing sodium and chloride data for each of the twelve active public wells in the project area are presented and discussed in the Section 3.4.2 of this document. Most of the active wells in the project corridor had relatively low sodium and chloride concentrations and were well below the state secondary drinking water standard of 250 mg/l. In fact, five wells had sodium and chloride concentrations that were both consistently below 50 mg/l. Three of these wells have sodium and chloride concentrations that averaged below 20 mg/l. Two other wells had sodium concentrations that were consistently higher than the chloride concentrations, which would clearly indicate that the source of sodium and chloride is not road salt but perhaps on-site treatment. Road salt is generally composed of 60 percent chloride and 40 percent sodium, and, therefore, chloride concentrations would generally always be higher than sodium when road salt is the principal source. Even if the existing sodium and chloride concentrations in these eight wells were to increase by 100 percent as a result of the increased road salt use on the four additional lanes proposed, the potential concentrations would still be well below secondary drinking water standard. For most of these wells, the future concentrations of sodium and chloride are expected to be below 100 mg/l.

The public wells that have the greatest risk of being impacted in terms of potentially exceeding the state secondary drinking water standard under proposed build conditions, are four wells that currently have sodium and chloride concentrations that are close to or above 100 mg/l. These four wells include the Pennichuck Water Works (PWW) wells located along the west side of Canobie Lake, the Yankee Trader (Citizens Bank) well and the Plaza-93 well that are both located along Route 111 within the Exit 3 Interchange and the well serving the Boumil Grove Condominium complex located in Londonderry and just south of the Exit 4 Interchange.

The PWW well field represents the largest public well system in the project corridor and is located on West Shore Road in Windham near Canobie Lake. Recent monitoring data indicates that chloride concentrations during one sampling event were as high as 333 mg/l but the corresponding sodium concentrations were no greater than 30 mg/l. Since the publication of the DEIS, NHDOT has learned that PWW utilizes an onsite water softening treatment system that adds potassium chloride to the water to reduce hardness levels. The system requires periodically discharging the backwash from the system to an onsite drywell. In March 2001, NHDES has issued a permit to allow the water supplier to discharge up to 775 gallons per day of backwash wastes in a dry well next to the adjacent wetlands and approximately 250 feet from Canobie Lake. Since the sodium concentrations observed in this well are relatively low, it would appear that the use of road salt on I-93 is having a minimal effect on the sodium and chloride concentrations in this well. The relatively high chloride concentrations observed in the water supply are likely to be due mostly to the use of the potassium chloride in the water softening system and associated backwash discharges that enter the surrounding groundwater. Thus, any future measure that NHDOT may potentially consider to reduce road salt use on I-93 within the contributing area of this well would likely have no substantial effect on sodium and chloride concentrations in this well.

Two other wells that have relatively high sodium and chloride concentrations are located within the Exit 3 Interchange area and include the wells at the Yankee Trader (Citizens Bank) and Plaza-93 (Dunkin Donuts) facilities. As mentioned earlier, the Plaza 93 facility would be acquired and the use of the well eliminated under proposed conditions with the “tight-shift” design option. The property owner for the Yankee Trader facility has stated that up until a few years ago a water softening system was used but it has been inoperable recently. The well is used to supply the internal plumbing facilities, but is not used for potable water.

The last of the four wells that have relatively elevated sodium and chloride concentrations consists of the community well serving the Boumil Grove Condominiums located just south of Exit 4 in Londonderry. Based on the recent results of the road salt sampling study, this well had chloride concentrations of 170 and 180 mg/l in January and March 2003, respectively, but then dropped to 32 mg/l in May 2003. Sodium concentrations were observed at 57 and 63 mg/l for the January and March sampling and then dropped to 27 mg/l in May. Previous data reported by NHDES revealed similar variability with an observed chloride concentration as high as 260 mg/l on September 28, 1998 but, two years later on September 27, 2001, the chloride concentration was 30.0 mg/l. The concentrations appear to vary widely and additional monitoring may be needed to ascertain the range of existing concentrations. The additional road salt use anticipated under proposed conditions has the potential to raise the chloride concentrations in this well to approach the state drinking water standard on a more consistent basis.

4.4.3.4 Secondary Impacts

The potential effects of secondary development on groundwater resources will depend largely on the locations and the extent to which secondary development may occur in the region. The analysis of secondary growth presented in Section 4.12 indicates that within the 29-community study area consisting of a total of 527,158 acres, 19,356 acres may be converted to residential land use while another 479-867 acres may be converted to commercial land uses due to the secondary population growth associated with the project. The estimated combined total represents about 4percent of the total land area within the study area. An even smaller percentage of the total land area would be associated with impervious surfaces since residential development generally results in 10 to 30 percent impervious surfaces in low to medium density development (Schueler 1987). See Section 4.12 for a complete discussion on estimates of secondary growth.

One of the principal groundwater concerns generally relates to the effects of land use changes on mapped stratified-drift aquifers within the region. As discussed in Section 3.4.2.1, there are two principal stratified-drift aquifers in the project corridor with one located in the southern Salem area and the other in the Derry/Londonderry area. Previous attempts to use these aquifers for municipal public water supply purposes have been abandoned by the Town of Salem in the southern aquifer and by the Town of Derry in the northern aquifer, due to poor water quality conditions. Both aquifers are already overlain by some of the most densely developed residential and commercial areas in the project area. In particular, the southern stratified-drift aquifer includes much of the impervious surfaces associated with the Rockingham Mall, Rockingham Race Track and the commercial businesses along NH Route 28. The moderate transmissivity portion of this aquifer extends west of Exit 1 along NH Route 38 and follows the main stem of Porcupine Brook. This area along NH Route 38 has experienced a considerable amount commercial development in the past few years and there has been an extensive amount of recent residential development throughout the Porcupine Brook watershed. This development pattern is expected to continue to occur regardless of the project given the population growth currently occurring in the southern New Hampshire. Given the proposed construction schedule for the project, any potential impacts caused by additional growth associated with this project are likely to be minimal relative to that associated with the existing development and the future development that will have occurred by the time the project is completed.

The same is true for much of the northern aquifer, the most productive portions of this aquifer (i.e., the mapped areas of moderate to high transmissivity) are currently overlain by the densely developed portions of Derry's downtown area. The Town of Derry's DPW facility, salt storage shed and the closed and capped landfill are also located in this portion of the aquifer. From a water quality standpoint, the potential effects of the existing development and related pollutant sources are likely to far outweigh any potential effects associated with the secondary development caused by

the proposed project. The effects of the proposed project on existing public wells are already discussed in Section 4.4.3.3.

Aside from the water quality effects on groundwater, the other potential concern relates to the effects on the available quantity. The two principal municipal water suppliers in the region, namely the Manchester Water Works (MWW) to the north and the Salem Water Department (SWD) rely on surface water resources for water supply. The SWD officials have indicated that the current average daily water demand is approaching their capacity especially during drought years. The SWD currently uses water from Canobie Lake during the summer months and is allowed to divert water from the Arlington Mill Reservoir only during non-summer months to augment supply. In recent years, the SWD has initiated preliminary studies to investigate the possibility of using the groundwater contained in bedrock fractures in the Salem Town Forest area in northwest Salem in the vicinity of the headwaters to Flatrock Brook. The initial results of these studies have not been highly favorable in terms of quality and quantity but additional studies will be needed to confirm whether bedrock fractures may be a viable water supply. The potential secondary growth associated with this project may help to perpetuate the need for this additional water supply source, but is not likely to adversely affect the quality or recharge aspects associated with this bedrock aquifer since the area is already protected as part of the Salem Town Forest. The other alternative for SWD to augment their existing supply in Canobie Lake involves seeking regulatory approval to divert water from the Arlington Mill Reservoir during the summer months when demand is high and the supply/recharge is generally low.

4.4.3.5 Mitigation

Consistent with NHDES's *Recommendations for Groundwater Protection Measures When Siting or Improving Roadways*, the need and type of groundwater protection measures have been evaluated for the various public wells and other groundwater resources identified in the project area. As discussed in Section 4.4.1, the proposed project will incorporate extended-detention basins and grassed swales to treat roadway runoff for nearly the entire new and reconstructed roadway, including existing pavement areas. This is consistent with NHDES's recommended measures under Level 2 protection measures for all new and improved roadways in Wellhead Protection Areas (WHPAs), locally designated groundwater protection areas or areas classified as GA1 areas (i.e., watersheds or recharge areas to existing or future water supplies) under the WHPA Program.

According to the NHDES criteria, Level 3 measures would be recommended for portions of the proposed reconstructed roadway near the Boumil Grove Condominiums in Londonderry just south of the Exit 4 Interchange area. This small community well is within 500 feet of the proposed roadway area. Level 3 measures include the use of impermeable materials beneath drainage swales, detention basins

and median areas to prevent the infiltration of runoff into the groundwater. Diversion of runoff outside of the WHPA will be evaluated as part of final design. Approximately 800 to 1000 feet of the southbound lanes and portions of the southbound on ramp would need Level 3 measures. In lieu of these measures, the possibility of connecting this condominium complex to the nearby municipal water system may also be explored.

With the "tight-shift" design option, which is the Selected Alternative for the Exit 3 improvements, the I-93 northbound lanes would move about 1,000 feet from the Pennichuck wells, which would only necessitate Level 2 mitigation measures. Without the" tight-shift" design option , then nearly 8,000 feet of the northbound lanes south of Exit 3 and including Exit 3 ramp areas may need to have Level 3 protection measures to protect the Pennichuck Water Company community well along West Shore Road near Canobie Lake in accordance with the NHDES Recommendations. This large community well is currently within 400 to 500 feet from the northbound lanes. The proposed widening would move the roadway about 75 to 100 feet closer if the "tight shift" option (Selected Alternative) was not utilized.

As discussed earlier, NHDOT will continue to investigate and explore opportunities to optimize and minimize the use of road salt for deicing purposes through advances in snow and ice control technology and maintenance decision-making. This includes the proposed installation of a Road Weather Information System (RWIS) as part of the project to provide real-time temperature and moisture data and enable the maintenance personnel to more accurately determine when road salt applications are needed and minimize or eliminate certain applications. Furthermore, NHDOT has begun utilizing salt brine applications on critical sections of I-93 in the vicinity of Canobie Lake and Cobbetts Pond to reduce overall sale-use. Some of the other recent advances include newly designed snow plows, improved access to detailed weather forecasting information, and various alternative deicers. See detailed discussion in Section 4.4.1.5.

NHDOT has also recently established a statewide Storm Water Management Plan as part of the NPDES Phase II Permit Program that includes conducting periodic education and outreach efforts to share ideas and information with local officials and contractors. These outreach efforts will include efforts to promote the more efficient use of road salt for snow and ice control though improved technology. NHDOT will also coordinate with regulated MS4 communities in addressing stormwater management and treatment measures, eliminating illicit discharges within the storm drain systems and implementing spill prevention and containment measures with emergency response personnel. NHDOT will prepare annual reports detailing the activities and efforts that were undertaken and how the measurable goals were met.

During the construction period, NHDOT will identify and specify precautions to minimize potential blasting impacts for all known public and private wells within 1000 feet of a blasting area as part of the final design. NHDOT will also coordinate with the

area utilities just prior to construction to prevent and repair any inadvertent damage to underground distribution lines.

NHDOT will investigate and replace any wells that have subsequently been found to be damaged or degraded as a result of NHDOT activities through its Well Replacement Program. In accordance with RSA 228: 34, NHDOT will conduct remedial measures for any wells that are found to have been impacted by construction or maintenance activities in relation to a state highway. The Well Replacement Program is initiated on an individual complaint basis. Once a complaint is received in writing regarding the nature of the impact, NHDOT will conduct an investigation to determine the most probable source of the impact. If it is found that NHDOT' activities are the most probable source, then NHDOT will initiate one of the following solutions:

- Replace or repair the damage to the supply well; or
- Pay damages in lieu of replacement or repair, or
- Purchase real property in lieu of replacement or repair, or
- Assist in coordinating and reimbursement to connect to a municipal water system.

Under the Safe Drinking Water Act, NHDES requires certain monitoring requirements for most public wells, which can assist in evaluating historical trends in specific parameters.

Lastly, in recognition of overall water quality concerns, NHDOT will provide funding of approximately $3.0 million to the NHDES Drinking Water Supply Land Grant Program to purchase property rights to aid in the protection and long-term viability of Massabesic Lake drinking water supply for Manchester and portions of Derry and Londonderry.

4.5 Floodplain Impacts

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4.5.1 Impact Methodology

The evaluation of floodplain impacts associated with the alternatives selected for detailed study uses information derived from the Federal Emergency Management Agency (FEMA) mapping for the study area. Floodplains (100-year frequency flood) were interpolated from FEMA Flood Insurance Rate Maps (FIRM) for each community traversed by the highway corridor. Floodways were interpolated where available from FEMA Flood Boundary and Floodway Maps for corridor communities.

FEMA defines the floodway as the channel of a stream, plus any additional floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried

without an increase in flood elevation greater than one foot. It should be noted that floodways have not been determined for all areas included in the FEMA studies, and floodway impacts are only presented for those streams for which available FEMA mapping identifies floodways.

The floodplain and available floodway data were transcribed onto the corridor constraint mapping, as presented in **Figure 3.5-1**. This information was overlaid with the proposed mainline and interchange options. From this analysis, floodplain and floodway impact areas were determined. No discernible differences in impacts were found among the mainline and interchange options. Table 4.5-1 presents floodplains and floodway impacts for various options and alternatives.

In addition to presentations at public informational meetings, several coordination meetings have been held with local and state officials and concerned citizens to discuss floodplain issues specific to this project. Agencies that have been involved to date include NHDOT, FHWA, FEMA, the New Hampshire Office of Emergency Management (NHOEM), the Town of Salem, the Spicket River Flood Mitigation Committee, and the Massachusetts Department of Environmental Management/Massachusetts Emergency Management Agency (MA-DEM/MEMA).

Due to the importance of Policy Brook and the Spicket River floodway and floodplain areas in the Town of Salem, a detailed analysis was completed for this system to fully evaluate potential impacts from the Selected Alternative.

Conclusions from this analysis indicate that the 100-year flood elevation of Policy Brook and the Spicket River will experience minor, if any, change as a result of the proposed highway improvements. As such, the proposed improvements will have a negligible impact on these watercourses' ability to convey floodwaters.

The analysis was completed using the USACOE's Hydraulic Engineering Center's River Analysis Software (HEC-RAS) computer program to create an "existing conditions" hydraulic model of the study area using actual ground survey cross sections that approximates a 100-year flood event. The study looked at a 1.3-mile section of Policy Brook between Kelly Road and its confluence with the Spicket River; and a 1.5-mile section of the Spicket River from its confluence with Policy Brook to just below its confluence with Harris Brook in Massachusetts.

Once the "existing conditions" hydraulic model was established, a "proposed conditions" hydraulic model was created by modifying the existing cross sections to reflect the roadway improvements associated with the Selected Alternative.

Table 4.5-1
Floodplains and Floodway Impacts (Acre-Feet)[1, 2]

	Salem						Windham		Derry / Londonderry								Londonderry / Manchester	
	Segment A 3 or 4 Lane		Segment B Exit 1 3 or 4 Lane		Segment C Exit 2 3 or 4 Lane		Segment D Exit 3 3 or 4 Lane		Segment E Exit 4 3 Lane				Segment E Exit 4 4 Lane				Segment F Exit 5 3 or 4 Lane	
			Reconstruct or Relocate Option		Loop or Diamond Option		Options 1-9		East Option		West Option		East Option		West Option		All Options at Exit 5	
Watercourse	Flood-plain	Flood-way	Flood-plain	Flood-way	Flood-plain	Flood-way	Flood-plain	Flood-way	Flood-plain	Flood-way	Flood-plain	Flood-way	Flood-plain	Flood-way	Flood-plain	Flood-way	Flood-plain	Flood-way
Spicket River	**0**	**2.4**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	**0**	**0**	0	0	**0**	**0**
Policy Brook	**15.0**	**0**	**0.5**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	**0**	**0**	0	0	**0**	**0**
Porcupine Brook/ Policy Brook	**0**	**0**	**0**	**0**	**12.5**	**0**	**0**	**0**	0	0	0	0	**0**	**0**	0	0	**0**	**0**
Harris Brook	**6.2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	**0**	**0**	0	0	**0**	**0**
Golden Brook Tributary	**0**	**0**	**0**	**0**	**0**	**0**	**1.5**	**0**	0	0	0	0	**0**	**0**	0	0	**0**	**0**
Beaver Brook	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	2.15	2.0	2.15	2.0	**2.3**	**2.4**	2.3	2.6	**0**	**0**
Wheeler Pond	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	1.1	0	.6	0	**1.55**	**.05**	.6	0	**0**	**0**
Tributary to Wheeler Pond	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	1.7	.4	.03	.02	**2.0**	**.5**	.03	.02	**0**	**0**
Cohas Brook/ Long Pond Brook	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	0	0	0	0	**0**	**0**	0	0	**2.1**	**0.7**
Total Floodplain Impact	**21.2**	**---**	**0.5**	**---**	**12.5**	**---**	**1.5**	**---**	4.95	—	2.78	—	**5.85**	**---**	2.93	—	**2.1**	**---**
Total Floodway Impact	**---**	**2.4**	**---**	**0**	**---**	**0**	**---**	**0**	—	2.4	—	2.02	**---**	**2.95**	—	2.62	**---**	**0.7**
Flood Storage Mitigation[3]	**68**		**25 - 26**		**42**		**15 - 17**		**4 - 6**								**1 - 3**	

1. See **Figure 2.3-23** for segment locations.
2. Bold = Selected Alternative
3. See Table 4.5-2.

■

4.5.2 Build Alternatives

The impacts resulting from the Build Alternatives are identified and discussed by segment. In all segments, except for Segment E, the floodplain and floodway impacts remain virtually the same for the Three-Lane and Four-Lane Alternatives. The reason for this similarity is due to the various environmental and engineering constraints identified during the conceptual design process with respect to widening the highway to the outside, towards the median, to the east or to the west. These constraints are identified in detail in Section 2.3.3 and briefly identified within the following impact discussion for each segment.

Segment A

For Segment A the Build Alternatives would have the same impact on floodplains of Harris Brook and Policy Brook and floodways associated with the most northern part of the Spicket River. The layouts for the Build Alternatives are exactly the same for Segment A, therefore the impacts are the same. The Segment A improvements would result in filling approximately 6.2 acre-feet of the Harris Brook floodplain, 15.0 acre-feet of Policy Brook floodplain and 2.4 acre-feet of Spicket River floodway. Beginning at the Massachusetts border in Salem and proceeding northerly to the Rest Area, impacts resulting from the widening of I-93 would occur along both the east and west side of the highway. All of the impacts to the Spicket River are related to the sound wall construction. The majority of impacts along the Policy Brook floodplain are also related to construction of a proposed sound wall. Although impacts to the floodplain and floodway of Policy Brook, Harris Brook and the Spicket River will occur, with some impacts related to the collector-distributor road and improved ramps into the Rest Area, the proposed improvements will have a negligible impact on these watercourses' ability to convey floodwaters. The impacts to the Harris Brook floodplain are all associated with the highway widening.

Segment B

The options for Segment B for either of the Build Alternatives would have a similar impact on floodplains. The Segment B improvements would impact approximately 0.5 acre-feet of floodplain associated with Policy Brook. This impact is a continuation of the floodplain impacts identified in Segment A along the east side of the roadway, just north of the Rest Area. No impacts to identified floodways are anticipated in this segment.

Segment C

The options for Segment C for either of the Build Alternatives would have a similar impact on floodplains associated with Porcupine Brook and Policy Brook. The impact from each of the alternatives would be approximately 12.5 acre-feet of floodplain, with no impacts to identified floodways. The proposed impacts in this segment

would occur as a result of the highway widening along the west side of I-93, north of NH 38 (Lowell Road), and along Pelham Road, east of I-93.

The widening of the southbound barrel would require replacement of the existing I-93 bridge over NH 38. This would require construction of a temporary bridge off line to the west to maintain two lanes of traffic during the construction of the new bridge. The layout for the temporary bridge would require construction of two temporary approach lanes within the floodplain, for both the Three-Lane and the Four-Lane Alternatives. The temporary bridge and approach fills would be removed following completion of the new bridge.

Segment D

The options for Segment D for either of the Build Alternatives would have similar impacts on the floodplain associated with Golden Brook. The impacts would involve approximately 1.5 acre-feet of floodplain with no floodway impacts as a result of widening both the NB and SB barrels, within the existing median area, in the vicinity of the weigh stations, north of Exit 3. In this location, the existing outside edge of pavement was held as a control at the weigh stations north of Exit 3, and the highway widening would occur towards the median. The resulting difference in impacts of the Three-Lane Alternative versus the Four-Lane Alternative in this location would be approximately 0.1 acres. However, with consideration of maintenance of traffic during construction, two temporary lanes would be required at all times so the resulting impacts would be very similar with either the 3-Lane or the 4-Lane Alternative.

Segment E

Segment E is the only highway section studied where the highway options result in differing impacts to floodplains and floodways. This is because the highway options include widening to the east or to the west. Similar to other segments, with consideration of maintenance of traffic during construction, the impacts associated with the Three-Lane Alternative would be similar to those with the Four-Lane Alternative.

Floodplain and floodway impacts will occur at the existing Beaver Brook crossing south of Exit 4, Wheeler Pond, and a tributary to Wheeler Pond northeast of Exit 4. For both the Three-Lane or Four-Lane Alternative, the west widening option would have the least impact. For the Three-Lane Alternative, the west option affects approximately 2.8 acre-feet of floodplain and 2.0 acre-feet of floodway, while under the Four-Lane Alternative 2.9 acre-feet and 2.6 acre-feet are affected, respectively. In contrast, the east widening option with the Three-Lane Alternative affects approximately 5.0 acres of floodplain and 2.4 acre-feet of floodway, while the Four-Lane Alternative affects 5.9 acre-feet and 3.0 acre-feet, respectively. The biggest difference between the east and west options occurs at Wheeler Pond and its tributary.

Segment F

Segment F for either of the Build Alternatives would have similar impacts on the floodplains and floodways associated with the existing Cohas Brook and Long Pond Brook crossings. The highway improvements under either of the alternatives would result in approximately 2.1 acre-feet of direct impact to floodplain and 0.7 acre-feet of direct impact to floodway.

Park-and-Rides

There will be no impacts on floodways or 100-year floodplains with the new park-and-ride lots proposed at Exits 2, 3 and 5.

Sound Walls

Since the proposed sound walls are being erected within the right-of-way, their impacts on floodways and 100-year floodplains have been taken into account in the above discussion for the Build Alternatives.

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4.5.3 No-Build Alternative

The No-Build Alternative would result in no new impacts to floodplains or floodways within the study area.

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4.5.4 Secondary Impacts

Secondary land use impacts associated with growth that may be stimulated by the I-93 widening are described in Section 4.12. However, the estimate of land conversion due to both residential and business growth does not provide a meaningful way to also estimate future impacts on floodplains. Floodplains are very localized on the landscape because they primarily lie along flowing waters. In addition, construction in floodplains is currently regulated at the community level per FEMA rules. Hence, a reasonable assumption is that there will be minimal involvement of floodplains with any future growth above that of the No-Build condition or that impacts that are incurred will be required to be appropriately mitigated by those responsible for those impacts. Involvement of floodplains with any future growth will also be regulated by existing Federal, State and local laws and ordinances.

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4.5.5 Mitigation

Direct impacts to the 100-year floodplain and floodways have been minimized in the preliminary design developed to date, and will continue to be considered during final design, by steepening highway embankments and/or utilizing retaining walls where appropriate. Such locations include the areas adjacent to the Spicket River, Policy Brook, and Porcupine Brook in Salem; Beaver Brook in Derry and Londonderry; Wheeler Pond in Londonderry; and Cohas Brook in Manchester.

To compensate for impacts specifically to the floodplains and flood storage areas along the greater Spicket River watershed, a series of basins will be constructed in both Salem and Windham as part of this project (see **Figure 4.5-1**). Up to 14 of these basins will be constructed at locations either immediately adjacent to impacted floodplains or in areas where natural valley storage is being lost. This approach is consistent with the conclusions of the 1990 USACOE report titled *General Investigation Study Spicket River Basin, Massachusetts and New Hampshire.* The report emphasized that both the loss of natural valley storage areas and direct impacts to the floodplain were contributing factors to flooding problems along the Spicket River. This approach was also discussed with representatives of the USACOE, FEMA, FHWA, and the Massachusetts Emergency Management Agency (MEMA) at a meeting held on November 6, 2001.

Additional flood storage compensation will be created at locations adjacent to flood susceptible brooks and rivers, and locations upgradient from flood prone areas through the water quality treatment measures. Up to 50 extended-detention basins are being proposed for both stormwater storage and water quality treatment at a number of locations along the widened highway (see Water Quality Sections 4.4.1.5 and 4.4.3.4 and **Figure 4.5-1**). These basins are typically designed to store up to a 50-year storm event before discharging to nearby watercourses.

The proposed wetland creation sites will also provide additional flood storage compensation. The floodflow alteration function of wetlands (i.e., storage and desynchronization) is one of the principal wetland functions affected by the project (see Section 4.6.2). Wetland creation sites include: the Pelham Road Mitigation Site, Waste Water Treatment Plant property, and Baggett Site in Salem; the Highway Median Site in Windham; and the South Road Mitigation Site in Londonderry (see Section 4.6.2.5 and **Figure 4.6-2**). The design goals for these sites, especially the Salem Waste Water Treatment Plant, include replacement of the floodflow alteration function.

A summary of the above described opportunities for compensatory flood storage is provided in Table 4.5.2. The watersheds where this mitigation will occur are listed and can be compared to the impacts by watercourse shown in Table 4.5-1.

Table 4.5-2
Flood Storage Opportunities Along the Project Corridor[1]

Type (Purpose)	Location	Town	Watershed	Estimated Flood Storage (ac. ft.)
Wetland Creation	Pelham Rd. Site (#31)	Salem	Spicket River	5
"	Salem Waste Water Treatment Plant (#32)	Salem	Spicket River	47 (max.)
"	Baggett Property (#38)	Salem	Spicket River	2
"	Highway Median (#24)	Windham	Spicket River	1-2
"	South Rd. Site (#14/15)	Londonderry	Beaver Brook	3
Compensatory Flood Storage Areas	Potentially 14 sites	Salem and Windham	Spicket River	92
Stormwater Extended-Detention Basins	Approximately 50 locations	Salem-Manchester	Corridor Watersheds	5-10
		Total		155-161

1 Refer to **Figure 4.5-1** for the specific watershed and flood storage locations relative to impacts.

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4.5.6 Floodplain Finding

All projects potentially impacting floodplains require an evaluation under Executive Order 11988, *Floodplain Management* (May 24, 1977). The regulation that sets forth the policy and procedures of this order is entitled Floodplain Management and Protection of Wetlands (44 CFR Part 9), which is under the authority of the FEMA. FHWA policies and procedures also cover the impact of projects on floodplains and floodways, and are found in *Location and Hydraulic Design of Encroachments on Floodplains* (23 CFR 650A).

This project has been carefully evaluated with respect to its effect on floodplains, practicable alternatives to such impacts and practicable mitigation measures as required under the provisions of Executive Order 11988, Floodplain Management and 23 CFR 650A.

Both the Three-Lane and Four-Lane Alternatives involve encroachment on the 100-year floodplain as well as floodway. The Three-Lane Alternative would encroach on an estimated 41 to 43 acre-feet of 100-year floodplain and 5 to 6 acre-feet of floodway depending on the particular interchange and widening options. In comparison, the Four-Lane Alternative would encroach on 41 to 44 acre-feet of 100-year floodplain and 6 acre-feet of floodway depending on the options selected. Additional impacts on the 100-year floodplain and floodway have been avoided by ensuring that all bridge widenings provide the same or greater spanning of the floodplains as the existing

bridges. The proposed detention basins along the highway will provide additional flood storage for 50-year storms. Offsetting these impacts would be the potential creation of about 160 acre-feet of compensatory flood storage throughout the corridor (Table 4.5.2).

The Selected Alternative (see Section 2.7) will encroach on approximately 43 acre-feet of 100-year floodplain and 6 acre-feet of floodway. The proposed flood storage mitigation will compensate for these impacts (Tables 4.5-1 and 4.5-2). A detailed analysis has been completed for Policy Brook and its confluence with the Spicket River to fully evaluate potential hydraulic impacts associated with the Selected Alternative. The analysis indicates that the Selected Alternative will have negligible impact on the ability of these watercourses to convey floodwaters. During final design, additional studies may be required for evaluating and minimizing local floodway impacts, particularly at major culvert crossings.

Based on the above considerations, it is determined that there is no practicable alternative to the proposed construction in floodplains and that the Selected Alternative includes all practicable measures to minimize harm to floodplains.

4.6 Land Resources Impacts

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4.6.1 Farmlands

4.6.1.1 Impact Methodology

Impacts on Important Farmland Soils (see Section 3.6.2 for definitions) were calculated by overlaying the alternative designs on maps identifying the particular soil series associated with prime, unique, state-wide important, and locally important farmlands (see **Figure 3.6-2**). Impacts were recorded for segments A through F. The Farmland Protection Policy Act (FFPA) of 1984 requires that all Federal agencies assess the effect of converting existing or potential farmland areas to non-agricultural use. The FFPA specifically directs federal agencies to (1) identify the effect of federally funded projects on farmland; (2) consider alternative actions to lessen impacts; and (3) ensure the project, to the extent practicable, is compatible with local, state, or federal programs to protect farmlands. FFPA specifically excludes areas identified through either state or local planning for commercial, industrial, or residential land uses. Lands already developed are also excluded from the analysis. Important farmland soils that lay within the I-93 right-of-way were hence excluded from analysis as having already been "converted" to

highway use. Results of the analysis were used to prepare the US Department of Agriculture's Farmland Conversion Impact Rating Form (see Appendix C)[42].

Impacts on active farmland or areas currently in use for row crops, hayfields/pastures, and orchards were estimated by visual inspection along the actual corridor.

4.6.1.2 Build Alternatives

Impacts to important farmland soils as well as active farmland are summarized in Table 4.6-1 and described below.

Three-Lane Alternative

Segment A

Approximately 0.4 acres of locally important farmland soils will be impacted by the Three-Lane Alternative in Segment A. These soils lie on both sides of the highway just north of the Massachusetts/New Hampshire state line. No other important farmland soils are impacted within this segment. No active farmland is affected.

Segment B

An estimated 0.3 acres of statewide important soils are impacted immediately adjacent to Exit 1 on the west side, while 0.3 acres of locally important soils are affected on both the west and east sides of the highway in Segment B under the Three-Lane Alternative. Some active farmland (0.4 acres) will be impacted in the southeast quadrant of Exit 1 for either the reconstruct or relocate options.

Segment C

Prime, statewide, and locally important farmland soils will be impacted at Exit 2 in the loop and diamond options for the 3-Lane Alternative, primarily north and west of the interchange. The two options will impact 3.2 acres and 2.9 acres of prime farmland soils, respectively, with most of the impact in the northeast quadrant of the interchange. In addition, the loop option will impact 2.7 acres of statewide important soils and 2.1 acres of locally important soils, whereas the diamond option will impact 1.6 acres of statewide and 2.0 acres of locally important soils. No active farmlands will be impacted with either option.

Segment D

Segment D contains 9 options. Farmland impact quantities were calculated for the entire segment and not for each option. There was little if any difference in impacts

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42 The totals shown on Form AD-1006 in Appendix C represents an over-estimation of farmland impacts as it includes impacts associated with the bike path on important farmland soils. Since the bike path is no longer being considered a part of the proposed project layout, the totals shown in Table 4.6-1 have been revised accordingly.

Table 4.6-1
Farmland Impacts (Acres) for the Build Alternatives as Compared to No-Build

			Salem					Windham	Derry/ Londonderry		Londonderry/Manchester				
			A	B		C		D	E		F				
				Exit 1		Exit 2		Exit 3	Exit 4		Exit 5				
	Options	No- Build	South of Cross Street	Reconstruct	Relocate	Loop	Diamond	Options 1-9	East	West	Relocate NH 28	Reconstruct NH 28	Relocate NB Ramp	Park & Rides (New Facilities at Exits 2, 3 and 5)	Total Impacts
Three-Lane Alternative	Prime Farmland Soils	No Impacts	0	0	0	3.2	2.9	0.3	0.5	0.4	0	0	0	0	3.6-4.0
	Farmland Soils of Statewide Importance	"	0	0.3	0.3	2.7	1.6	0.4	0	0	0.3	0.3	0.3	0 Negligible	2.6-3.7
	Farmland Soils of Local Importance (Acres)	"	0.4	0.3	0.3	2.1	2.0	0	0	0.5	0.3	0.3	0.3	0	3.0-3.6
	Total	"	0.4	0.6	0.6	8.0	6.5	0.7	0.5	0.9	0.6	0.6	0.6	0	9.3-11.2
	Active Farmland	"	0	0.4	0.4	0	0	0	0	9.0	0	0	0	0	0-4-9.4
Four-Lane Alternative	Prime Farmland Soils	No Impacts	**0**	0	**0**	3.2	**3.1**	**0.3**	**0.8**	0.4	0	**0**	0	**0**	3.8-4.3
	Farmland Soils of Statewide Importance	"	**0**	0.3	**0.3**	2.7	**1.6**	**0.4**	**0**	0	0.3	**0.3**	0.3	**Negligible**	2.6-3.7
	Farmland Soils of Local Importance (Acres)	"	**0.4**	0.4	**0.4**	2.2	**2.2**	**0**	**0**	1.2	0.3	**0.3**	0.3	**0**	3.3-4.5
	Total	"	**0.4**	0.7	**0.7**	8.1	**6.9**	**0.7**	**0.8**	1.6	0.6	**0.6**	0.6	**0**	10.1-12.1
	Active Farmland	"	**0**	0.4	**0.4**	0	**0**	**0**	**0**	9.0	0	**0**	0	**0**	0.4-9.4

Bold = Selected Alternative.

among the options. Options 1 through 9 in Segment D for the Three-Lane Alternative will impact 0.3 acres of prime farmland soils and 0.4 acres of statewide important farmland soils. Prime farmland soil impacts are located along Bridge Street in Windham. Impacts to statewide important soils occur off Morrison Road and North Lowell Road in Windham. No locally important farmland soils or active farmland will be impacted in Segment D. No active farmland will be affected within Segment D.

Segment E

The impacts to important farmland soils in Segment E for the Three-Lane Alternative occur adjacent to Pillsbury Road, north of Exit 4 as well as directly along the existing mainline. Prime farmland will be impacted almost equally if the existing highway is widened to the east or the west, impacts will be 0.5 and 0.4, respectively. There will be no impacts to statewide important soils. However, there will be an impact to the locally important soils (0.5 acres) if the mainline is widened to the west. There will be no impacts to active farmland for the easterly widening of Segment E. The westerly widening would affect slightly less than 5.4 acres of the active Woodmont Orchard property for right-of-way acquisition and a little less than 3.6 acres for slope work.

Segment F

Important farmland soils are situated in various locations along the mainline in this segment. Primary areas include land surrounding Long Pond Brook, Bodwell Road, Island Pond Road, and Cohas Avenue in Manchester. A majority of these sites are either developed or already committed to development and are therefore excluded from the analysis. However, there are small portions of statewide important and locally important soils that are not developed and will be impacted to the same extent (0.3 acres) by any of the three options within Segment F. There will be no impacts to active farmlands within this segment.

Four-Lane Alternative

Segment A

Since the designs for both the Three-Lane and Four-Lane Alternatives are the same for this segment, approximately 0.4 acres of locally important farmland soils will be impacted by the Four-Lane Alternative in this segment. These soils lie on both sides of the highway just north of the Massachusetts/New Hampshire state line. No other important farmland soils are impacted in Segment A. No active farmland is affected.

Segment B

Approximately 0.3 acres of statewide and 0.4 acres of locally important farmland soils will be impacted in this segment on both the west and east sides of the highway in Segment B under the Four-Lane Alternative. Approximately 0.4 acres of active farmland is impacted under either the reconstruct or relocate options in the southeast quadrant of Exit 1 under the Four-Lane Alternative.

Segment C

Prime, statewide, and locally important farmland soils will be impacted at Exit 2 for either the loop or diamond options under the Four-Lane Alternative, primarily north and west of the interchange. The loop option will impact 3.2 acres of prime farmland, whereas 3.1 acres of prime farmland will be impacted in the diamond option with most of the impacts in the northeast quadrant of the interchange. The loop option will impact 2.7 acres of statewide important farmland soils, whereas the diamond option will impact 1.6 acres of that same type. Impacts to locally Important farmland soils are equal for both the loop and diamond options (2.2 acres). No active farmlands will be impacted with either option at Exit 2.

Segment D

Segment D contains 9 options. Farmland impact quantities were calculated for the entire segment and not for each option. There was little if any difference in impacts among the options. Options 1 through 9 will impact 0.3 acres of prime farmland soils and 0.4 acres of state important farmland soils. Prime farmland soil impacts are located along Bridge Street in Windham. Statewide important farmland soil impacts occur off Morrison Road and North Lowell Road in Windham. No locally important farmland soils are impacted in this segment. No active farmland will be affected within Segment D.

Segment E

Important farmland soils are impacted in this segment adjacent to Pillsbury Road, north of Exit 4 as well as directly along the existing mainline. There will be a greater impact to prime farmland, if the existing highway is widened to the east (0.8 acres) rather than to the west (0.4 acres). An estimated 1.2 acres of locally important farmland soils will be impacted if the widening takes place to the west. There will be no impacts to statewide important farmland soils for either the east or west widening options in this segment. Widening to the west will require acquisition of approximately 5.4 acres of the active Woodmont Orchard property for new right-of-way, while another 3.6 acres will likely be affected by slope work.

Segment F

Important Farmland soils are located in various locations along the corridor. Primary areas include land surrounding Long Pond Brook, Bodwell Road, Island Pond Road, and Cohas Avenue in Manchester. A majority of these locations are either already developed or committed to development and hence not subject to the FPPA. However, there are small portions of statewide important and locally important farmland soils in areas that are not developed and that will be impacted under all three options for this segment (approximately 0.3 acres for each). There will be no impacts to active farmlands within this segment.

Four-Lane/Three-Lane Combination

A third alternative is the combination of four lanes beginning at the state line and extending through to Exit 3 and then switching to three lanes north of Exit 3 to the I-93/I-293 split in Manchester. Hence, for Segments A-D the same impacts as for the Four-Lane Alternative will occur, while for Segments E-F they will be the same as described for the Three-Lane Alternative.

Park-and-Rides

New park-and-ride lots are proposed at Exits 2, 3 and 5. Impacts on important farmland soils are very small or negligible for the locations chosen.

Sound Walls

Since the sound walls are being erected within the highway right-of-way (either existing or proposed), the conversion of farmland soils for the walls has already been taken into account in the estimates described above.

Farmland Conversion Form

Total farmland impacts were evaluated using the US Department of Agriculture's Farmland Conversion Impact Rating Form (AD-1006; Appendix C). For simplicity the same component options (i.e., South of Cross Street in Segment A, Relocate at Exit 1, Diamond Interchange at Exit 2, Option 8 at Exit 3, the Easterly Widening at Exit 4, and Reconstruct NH 28 at Exit 5) were assumed in evaluating the Three-Lane, Four-Lane, and Four-Lane/Three-Lane Combination Alternatives. A "worst case" Four-Lane Alternative was also evaluated to represent the full range of impacts possible. Data for Parts I, III, and VI were provided by NHDOT. The NRCS completed Parts II, IV, and V. The final scores for each alternative (Part VII) and corridor selection (Part VIII) were completed by NHDOT in cooperation with FHWA.

Alternatives receiving a total score of less than 160 points are given minimal level of consideration for protection and no additional alternatives need to be evaluated (*Supplemental Guidance for Implementation of Farmland Protection Act, FHWA, January 23, 1985*). None of the alternatives has a score which exceeds the 160 point threshold requiring further coordination with NRCS.

4.6.1.3 No-Build Alternative

The No-Build Alternative will not affect important farmland soils or active farmland since there would be no new construction.

4.6.1.4 Secondary Impacts

Secondary land use impacts are described in Section 4.12. The land conversion estimates attributed to potential future population growth and the associated residential and business development are provided. It is difficult to estimate how much important farmland soil areas may be affected by the possible growth attributed to I-93 widening. These projections are speculative and dependent to a large extent on local land use regulations and policies. As a general approximation for planning considerations, it was assumed that about 31 percent[43] of the landscape in the secondary impacts study area contains important farmland soils. The possible future conversion of an additional 20,100 acres of land under the Build condition may therefore equate to about 6,230 acres of farmland soils affected.

4.6.1.5 Mitigation

No mitigation other than avoidance and minimization is available for this resource, since loss of important farmland soils and the productivity associated with them for highway construction is an irretrievable and irreversible commitment of resources. Property owners will be compensated through the right-of-way and acquisition process for unavoidable impacts. Any topsoil (i.e., loam) salvaged during construction will be re-used on roadway side slopes. Additionally, Form AD-1006 shows that important farmland soil impacts do not exceed the threshold requiring further coordination with NRCS.

■

4.6.2 Wetland Resources

NEPA, Section 404 of the Clean Water Act, and Executive Order 11990 require consideration of impacts to wetland acreage and functions and values. Other impacts considered include habitat fragmentation, the effects of runoff (erosion, sedimentation, flooding), impoundment, and other hydrologic modifications, and temporary disturbances incurred during road construction that may adversely affect wetland functioning.

Twenty-seven wetland systems have been identified within the I-93 project corridor. Wetland resources were mapped and evaluated according to the methodologies described previously in Section 3.6.3.

The majority of wetlands throughout the project study area comprise a network of interconnected systems contained within five major watersheds and several subwatersheds. In general, wetlands located within the southern one-third of the project corridor are more disturbed, altered, and fragmented than those in the

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43 Average for the three counties of Hillsborough, Rockingham, and Merrimack Counties. Source: Steven Hundley, NRCS Office, Durham, NH, October 9, 2003.

northern two-thirds. Proximity to existing roads and commercial and residential development have degraded portions of most wetlands from the Massachusetts border extending to the weigh stations in Windham. Other wetlands, north of the weigh stations to the northerly project terminus, have been adversely affected to a lesser degree by adjacent land development.

As described in Section 3.6.3, a functional assessment of wetlands within the project corridor was performed in the field using the USACOE Highway Methodology (see Table 3.6-3). In general, most wetland systems were determined to possess between six and nine functions and values. The following wetland systems were determined to have attributes supporting 12 functions and values: NH 111 (Wetland System 13), Wheeler Pond and Tributary (Wetland System 21), and the Exit 5 Wetland (Wetland System 25). With regard to principal functions, in general, the assessments show that wetlands south of the weigh stations provide between three and six principal functions, whereas, wetlands to the north of the weigh stations provide between four and eight principal functions. The proposed compensatory mitigation package would consider the wetland functions and values lost due to project-related impacts and would compensate, to the degree practicable, those lost functions and values.

Impacts to wetlands associated with both the Three-Lane and Four-Lane Alternatives, and the Four-Lane/Three-Lane Alternative are described in the following sections. Compensatory mitigation to offset these proposed project impacts is discussed in Section 4.6.2.4.

4.6.2.1 Impact Methodology

For purposes of comparing alternatives, the areas of wetland impacts were determined by measuring the wetland area to be permanently cut or filled (including clear zones and easements) based on wetland mapping. The total amount of permanent wetland impact for each system, as well as amount of impact by cover type within each wetland, was determined.

4.6.2.2 Build Alternatives

Both the Three-Lane and Four-Lane Alternatives consist of similarly designed options, with the Four-Lane Alternative construction options extending an additional lane in each direction (approximately 24 feet in total) beyond the Three-Lane Alternative options. Permanent impacts associated with the Four-Lane Alternative are therefore greater than those of the Three-Lane Alternative. However, in order to maintain traffic during construction, the Three-Lane Alternative must be constructed with a temporary widening. The acreage of wetland impacts for the Three-Lane Alternative will therefore be similar to the impact of the Four-Lane Alternative, at least temporarily.

Certain proposed options, (i.e., relocation options at Exit 1 and 5, loop option at Exit 2, the northbound/southbound tight shift options at Exit 3, and the east option at Exit 4), result in greater wetland impacts than their alternative options. See **Figure 4.6-1**, which provides a graphical representation of wetland impacts for each alternative and option.

Direct wetland impacts, i.e., the loss of wetland acreage within the highway footprint, vary from 52.9 acres to 78.7 acres depending on the construction options chosen (not including park-and-ride lots addressed later in this section). In general, the proposed highway reconstruction follows an existing corridor. As such, the bulk of the direct wetland impacts are along the edge of wetland systems that have already been impacted by the highway construction. In most cases, these "edge impacts" represent only a small percentage of the total wetland acreage within a system and, while representing an incremental loss of wetland area, will not eliminate the functions and values performed by the remaining wetland. Exceptions to this generality are called out in the segment-by-segment discussion contained below.

Indirect impacts can also result from highway construction. For example, the loss of forest overstory adjacent to a wetland, stream, or vernal pool can eliminate shading, increase water temperature and adversely affect the ecological community. Exposure of wetland systems to noise from highway traffic can adversely affect the quality of wildlife habitat that wetlands provide. And increased sedimentation and nutrient pollution can impair water quality within wetlands and streams if stormwater controls are inadequate or not maintained.

Hydrological changes to wetlands can sometimes occur as a result of highway construction. The extension of culverts or placement of new culverts not only impacts stream bed habitat, but can affect hydrology within wetland systems, either flooding or draining a wetland area depending on how the culvert is installed. These hydrological modifications can lead to changes in the cycling of nutrients and biomass within the wetland system and can allow for a shift in the plant community associated with the area. In some cases, these changes might actually lend additional support to functions already performed by the wetlands. But, in other cases, such hydrological changes will degrade or destroy the wetland.

The results of the wetland functional analysis shows that nearly every wetland system impacted by this project serves to reduce flooding, to retain sediments and toxicants and therefore benefit water quality, and to provide wildlife habitat. Thus, direct wetland impacts will affect these most common functions to some degree. Again, since most of the wetland impacts resulting from the highway upgrade will be to the edge of systems previously impacted by the highway's original construction, and since in most cases the direct impact is a relatively small percentage of the total wetland acreage within the system, it is expected that the incremental impacts will not result in elimination of functions and values of the remaining wetland areas.

Direct impacts to wetlands associated with both the Three-Lane and Four-Lane Alternatives are described in more detail in the following sections, by highway segments, A through F. **Figure 4.6-1** presents specific impacts to wetland cover types that would result from each option within the Three-Lane and Four-Lane Alternatives.

Three-Lane Alternative

Depending on which options are selected, impacts to wetland systems due to the Three-Lane Alternative vary from 52.9 acres to 68.2 acres (not including park-and-ride lots). Impacts associated with the various construction options are summarized in **Figure 4.6-1** and Tables 4.6-2.

Four-Lane Alternative

Depending on which options are selected, impacts to wetland systems due to the Four-Lane Alternative vary from 62.0 acres to 78.7 acres (not including park-and-ride lots). Impacts to wetlands for the Four-Lane Alternative in all Segments are substantially similar to those reported for the Three-Lane Alternative. Because of the slightly larger widening, permanent impacts are somewhat higher as shown in **Figure 4.6-1** and Table 4.6-3.

Four-Lane/Three-Lane Combination

A third alternative is the combination of a 4-lane section beginning at the state line and extending to Exit 3 and then switching to a 3-lane section after Exit 3 northerly to the I-93/I-293 split in Manchester. As the Four-Lane/Three-Lane Combination Alternative does not propose any new options, the impacts are the same relative to the specific segments as described in the previous sections. The total range of wetland impacts associated with the Four-Lane/Three-Lane Combination alternative varies from 55.0 acres to 70.5 acres depending on which option is constructed.

Build Impacts by Segment

The following discussion summarizes the impacts to each wetland system by segment, compares impacts among options and highlights potential adverse effects to wetland functions.

Segment A

In Segment A, only one option is proposed. Impacts to Wetland Systems 1 and 2 would total 3.7 acres for the Three-Lane Alternative and 3.9 acres for the Four-Lane Alternative (see Tables 4.6-2 and 4.6-3).

Most notably in Segment A, the highway upgrade will directly impact forested wetlands along the banks of Policy Brook (Wetland System 1). The construction may also have indirect impacts to the Brook by removing forest cover along its western

bank. This impact is associated with the widening of the highway and with the construction of a sound wall designed to mitigate the highway's noise impact on Salem's Haigh Avenue neighborhood. Policy Brook and its associated wetlands should continue to perform all of their present functions under the Build Alternatives, but the wetland's ability to serve as finfish and shellfish habitat may be adversely affected by the loss of adjacent forest cover (*i.e.,* loss of shading).

Highway construction in Segment A will also cause impact to Wetland System 2, a large red maple swamp to the west of the highway. This forested system contains an intermittent tributary to the Harris Brook, which will be moved as a result of the construction. The direct impact to Wetland System 2 is expected to incrementally reduce the amount of floodflow alteration provided by this wetland.

Segment B

Two construction options are being proposed in Segment B: Reconstruction of the Exit 1 southbound on- and off-ramps and Relocation of the ramps at Exit 1. Impacts to Wetland Systems 1 and 2 in Segment B are nearly identical between the two options. However, impacts to Wetland System 3 (Porcupine Brook Tributary and an associated red maple swamp) are substantially different, with the Reconstruct Option having 3.7 acres of impact while the Relocate Option will have approximately 7.9 acres of impact (8.2 acres for the Four-Lane Alternative).

Regardless of which option is chosen, the impacts to Wetland Systems 1 and 2 in Segment B are associated with incremental edge impacts that are not expected to substantially alter these wetland's ability to provide their current functions and values.

The Porcupine Brook Tributary Swamp (Wetland System 3) is an important complex of forested, scrub-shrub, and shallow open water. Portions of the wetland system to the west of the current Exit 1 location are relatively expansive and undisturbed and provide excellent wildlife habitat, among several other functions and values. It is this western portion of Wetland System 3 that is most substantially impacted by the construction in Segment B. Salem Prime Wetland #16 is located approximately 150 feet from construction work (filling, grading, paving, etc.) associated with relocation of the southbound ramps. In particular, the reconstruction or relocation of the Exit 1 southbound ramps will require substantial impacts to portions of the swamp which may adversely affect wildlife habitat.

Segment C

In Segment C, two construction options at Exit 2 (loop and diamond) are being considered. While both options impact Wetland Systems 3 through 8, the loop option results in greater wetland impacts than the diamond option as shown in Tables 4.6-2 and 4.6-3.

Among the more important wetland systems in the project area, Porcupine Brook and its associated wetlands (Wetland System 4) wind their way southeasterly through the project area between Exits 1 and 2. In fact, the Brook and its wetlands parallel the existing highway within the median for 1,700 feet just north of the Lowell Road (NH 38) overpass. Porcupine Brook supports a substantial red maple floodplain forest. A portion of Wetland System 4 located east and west of the highway is designated as Salem Prime Wetland #17. Impacts to this system and its floodplain within the median are kept to a minimum, and there are no direct impacts to the Prime Wetland portions of the system, but a narrow forested portion to the west will be lost almost in its entirety (non-prime wetland). Because impacts directly adjacent to Porcupine Brook are avoided, this system should continue to provide its current wetlands functions (*e.g.*, floodflow alteration, finfish habitat, etc.), albeit at reduced levels. Note that the loop option has slightly greater impacts to Wetland System 4 (2.6 acres for the Three-Lane Alternative vs. 2.9 acres for the Four-Lane) than the diamond option (2.4 acres vs. 2.7 acres for the Three and Four-Lane Alternatives respectively).

Wetland System 5 includes portions of forested, scrub-shrub, and emergent wetlands located inside the existing Exit 2 southbound ramps. This system is degraded to some degree by its landscape position adjacent to the highway and industrial/commercial land uses, but still provides water quality functions and some wildlife habitat. Both the Loop and Diamond options at Exit 2 will impact the forested and scrub-shrub wetland communities in the southwest portion of the interchange. The Diamond option, however, avoids impacts to the emergent marsh in the northwest portion of the interchange and therefore has lower overall impacts to this wetland (3.1 acres vs. 4.7 acres).

Both the Loop and Diamond Options will have similar impacts in Wetland System 6 and will cause a small incremental loss of this system's ability to provide wildlife habitat. Most notably, reconstruction of the northbound on-ramp at Exit 2 will eliminate a portion of a depressional forested wetland within this system.

Wetland System 7, a small area associated with an intermittent stream, will be nearly entirely filled by the highway upgrade. Both the Loop and Diamond Options have this effect, which will eliminate all of the wetland's existing functions and values.

Expansion of the highway and construction of a sound wall in the vicinity of Salem's South Shore Road neighborhood will impact small portions of the periphery of Wetland System 8. These edge impacts represent only a small incremental reduction in the ability of this system to provide wetland functions.

Segment D

In Segment D, nine different construction options are being considered. Each of the options (1 through 9), would impact portions of Wetland Systems 9 through 17. In

general, the Tight Shift Options (Options 7, 8 and 9) tend to have more impact than the Northbound Shift Options (Options 1 - 6). See Tables 4.6-2 and 4.6-3 for a summary.

Impacts to Wetland System 9, a relatively small forested wetland dominated by red maple and swamp white oak, are identical among the options. Approximately 0.4 to 0.7 acres of this 2.0 acre system will be impacted by the Build Alternatives, causing a proportional loss of wetland functions.

The Tight-Shift Options will create greater impacts to Wetland Systems 10 and 11 (3.6 acres total for the Three-Lane Alternative or 4.5 acres for the Four-Lane Alternative), than the Northbound Shift Options (1.4 acres or 1.9 acres for the two alternatives respectively). A mixture of forested, emergent, and scrub-shrub cover types, these two systems provide water quality functions up gradient of Canobie Lake. In particular, the Tight-Shift Options will result in the loss of a substantial portion of a 2.4 acre emergent and scrub-shrub wetland in Wetland System 10 and a large area of a similar environment in Wetland System 11. These marshes are located between the northbound and southbound barrels approximately 1,200 feet northwest of Canobie Lake. Loss of the emergent/scrub-shrub fraction of this system will adversely impact the system's ability to provide sediment/toxicant removal and nutrient uptake.

Wetland System 12, south of NH 111 near Exit 3 has a diverse mixture of forested, scrub-shrub and emergent wetlands that provide ten of the standard wetland functions. The system contains two perennial tributaries to Cobbetts Pond that provide fish habitat and recharge to the pond. All Build Alternatives will eliminate an emergent portion of the system located between the two highway barrels, which will reduce the system's ability to provide water quality functions.

Wetland System 13, a system of relatively narrow side hill forested wetlands will be impacted by construction along NH 111 in Windham. NH 111 crosses these wetlands more or less perpendicularly. They provide several principal functions including wildlife habitat and recharge to Cobbetts Pond. The full relocation of NH 111 will have roughly twice as much impact to these systems as its reconstruction in its current alignment.

Impacts to Wetland Systems 14, 15, 16 and 17 in the vicinity of the Windham Weigh Station are identical among all nine options, and are limited to edge impacts that will have minor incremental effects. (With the exception of the impacts to Vernal Pool 13 in Wetland System 14. See discussion below and in the discussion on vernal pools in Section 4.6.3.)

Segment E

In Segment E, two construction options are being considered, the East and West Options. Both options would impact portions of Wetland Systems 18 through 23. In total, wetland impacts due to the East Option would amount to 14.1 acres for the

Table 4.6-2
Summary of Wetland Impacts, All Segments
Three-Lane Alternatives

			Segment A	Segment B Exit 1		Segment C Exit 2		Segment D Exit 3									Segment E Exit 4		Segment F Exit 5		
Wetland Number	Wetland Name	Total Wetland Area	So. Cross St.	Recon.	Reloc.	Loop	Diam	Opt 1	Opt 2	Opt 3	Opt 4	Opt 5	Opt 6	Opt 7	Opt 8	Opt 9	East	West	Reloc NH 28	Recon NH 28	Reloc NB Ramp
1	Policy Brook/Spicket River	3.7 ac.	0.8 ac	0.1 ac.	0.3 ac																
2	Harris Brook Tributary	22.3	2.9	0.1	0.1																
3	Porcupine Brook Tributary	40.2		3.7	7.9	1.0 ac.	1.0 ac.														
4	Porcupine Brook	21.5				2.6	2.4														
5	Exit 2	13.1				4.7	3.1														
6	Policy Brook	13.1				2.7	2.7														
7	Porcupine Brook Tributary	1.0				0.6	0.6														
8	Canobie L South Tributary	2.3				0.6	0.4														
9	No. Tributary to Policy Brook	2.0						0.4 ac.	0.4 ac.	0.4 ac.	0.4 ac.	0.4 ac.	0.4 ac.	0.4 ac.	0.4 ac.	0.4 ac.					
10	Canobie Lake West Trib.	8.3						0.6	0.6	0.6	0.6	0.6	0.6	1.7	1.7	1.7					
11	Route 111A	28.6						0.8	0.8	0.8	0.8	0.8	0.8	1.9	1.9	1.9					
12	Exit 3	19.8						4.9	4.9	6.0	6.0	3.7	3.7	5.3	5.3	5.3					
13	Route 111	17.1						1.0	1.0	2.2	2.2	2.2	2.2	1.0	2.1	2.1					
14	Weigh Stations South	5.4						1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3					
15	Weigh Stations North	11.6						1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6					
16	Bridge Street Pond	7.1						0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1					
17	Windham North	14.9						0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3					
18	Derry South	11.8															1.4 ac.	1.4 ac.			
19	Derry Central/North	16.9															2.8	3.0			
20	Beaver Brook	23.5															3.4	2.0			
21	Wheeler Pond and Trib	15.4															2.0	1.0			
22	Pillsbury Rd to PSNH	28.5															4.3	2.7			
23	Stonehenge Road	13.5															0.2	0.3	0.5 ac.	0.5 ac.	0.5 ac.
24	Londonderry Central	10.9																	1.2	1.2	3.7
25	Exit 5	46.9																	5.8	5.8	4.3
26	Cohas Brook	31.7																	5.1	5.1	5.1
27	I-93/I-293 Interchange	45.0																	1.4	1.4	1.4
	Total Impacts (acres)		3.7	3.9	8.3	12.2	10.2	11.0	11.0	13.3	13.3	11.0	11.0	13.6	14.7	14.7	14.1	10.4	14.0	14.0	15.0

Notes: "Wetland Area" is the total area of the wetland within the study corridor within 1,000 feet of the highway centerline. In some cases, wetland systems may extend outside of this zone and therefore total wetland area will be an underestimate. Totals in this table will not agree in all cases with those reported in **Figure 2.6-2 and Figure 4.6-1** due to rounding. Note that changes in the estimated impacts to Wetland System 12 and 25 relative to those reported in the Draft EIS are due to the redesign of Route 111A (Wetland System 12) and to a more accurate delineation of wetland resources in the vicinity of the Exit 5 Park-and-Ride (Wetland System 25).

Table 4.6-3
Summary of Wetland Impacts, All Segments
Four-Lane Alternatives

			Segment A	Segment B Exit 1		Segment C Exit 2		Segment D Exit 3									Segment E Exit 4		Segment F Exit 5		
Wetland Number	Wetland Name	Total Wetland Area	So. Cross St.	Recon.	Reloc.	Loop	Diam	Opt 1	Opt 2	Opt 3	Opt 4	Opt 5	Opt 6	Opt 7	Opt 8	Opt 9	East	West	Reloc NH 28	Recon NH 28	Reloc NB Ramp
1	Policy Brook/Spicket River	3.7 ac	**0.7 ac**	0.1 ac	**0.1 ac**																
2	Harris Brook Tributary	22.3	**3.2**	0.1	**0.1**																
3	Porcupine Brook Tributary	40.2		3.7	**8.2**	1.0 ac	**1.0 ac**														
4	Porcupine Brook	21.5				2.9	**2.7**														
5	Exit 2	13.1				4.7	**3.1**														
6	Policy Brook	13.1				2.7	**2.5**														
7	Porcupine Brook Tributary	1.0				0.6	**0.6**														
8	Canobie L South Tributary	2.3				0.7	**0.7**														
9	North Trib to Policy Br	2.0						0.7 ac	0.7 ac	0.7 ac	0.7 ac	0.7 ac	0.7 ac	0.7 ac	**0.7 ac**	0.7 ac					
10	Canobie L West Trib	8.3						0.9	0.9	0.9	0.9	0.9	0.9	2.4	**2.4**	2.4					
11	Route 111A	28.6						1.0	1.0	1.0	1.0	1.0	1.0	2.1	**2.1**	2.1					
12	Exit 3	19.8						4.9	4.9	6.0	6.0	3.7	3.7	5.3	**5.3**	5.3					
13	Route 111	17.1						1.0	1.0	2.2	2.2	2.2	2.2	1.0	**2.1**	2.1					
14	Weigh Stations South	5.4						1.4	1.4	1.4	1.4	1.4	1.4	1.4	**1.4**	1.4					
15	Weigh Stations North	11.6						1.9	1.9	1.9	1.9	1.9	1.9	1.9	**1.9**	1.9					
16	Bridge Street Pond	7.1						0.1	0.1	0.1	0.1	0.1	0.1	0.1	**0.1**	0.1					
17	Windham North	14.9						0.5	0.5	0.5	0.5	0.5	0.5	0.5	**0.5**	0.5					
18	Derry South	11.8															**1.5 ac**	1.5 ac			
19	Derry Central/North	16.9															**3.0**	3.3			
20	Beaver Brook	23.5															**4.2**	3.5			
21	Wheeler Pond and Trib	15.4															**2.3**	0.5			
22	Pillsbury Rd to PSNH	28.5															**7.0**	4.4			
23	Stonehenge Road	13.5															**0.4**	0.5	1.0 ac	**1.0 ac**	1.0 ac
24	Londonderry Central	10.9																	1.5	**1.5**	4.1
25	Exit 5	46.9																	8.8	**8.8**	7.5
26	Cohas Brook	31.7																	5.1	**5.1**	5.1
27	I-93/I-293 Interchange	45.0																	1.4	**1.4**	1.4
	Total Impacts (acres)		**3.9**	3.9	**8.4**	12.6	**10.6**	12.4	12.3	14.7	14.7	12.4	12.4	15.4	**16.5**	16.5	**18.4**	13.7	17.9	**17.9**	19.1

Notes: "Wetland Area" is the total area of the wetland within the study corridor within 1,000 feet of the highway centerline. In some cases, wetland systems may extend outside of this zone and therefore total wetland area will be an underestimate. Totals in this table will not agree in all cases with those reported in **Figure 2.6-2 and Figure 4.6-1** due to rounding. Note that changes in the estimated impacts to Wetland System 12 and 25 relative to those reported in the Draft EIS are due to the redesign of Route 111A (Wetland System 12) and to a more accurate delineation of wetland resources in the vicinity of the Exit 5 Park-and-Ride (Wetland System 25).
Bold = Selected Alternative.

Three-Lane Alternative or 18.4 acres for the Four-Lane Alternative, while impacts due to the West Option would total 10.4 acres or 13.7 acres for the Three- and Four-Lane Alternatives respectively. See Tables 4.6-2 and 4.6-3 for a summary.

Wetland System 19 is a large and diverse mixture of emergent, forested and open water components that contains Derry Prime Wetland #6F and #7F. Direct impacts to the prime wetland are avoided, although some clearing and grading will occur adjacent to the prime wetland. Additionally, a portion of the non-prime portion of Wetland System 19 will be filled within the highway median and to the west of the highway. Because this wetland occurs on both sides of the highway, complete avoidance is not possible under the Build Alternatives, although the East Option result in slightly lower impacts overall compared to the West Option.

Beaver Brook and associated wetlands (Wetland System 20) will be impacted by the highway widening. Beaver Brook is an important freshwater stream that flows from Beaver Lake in Derry, and extends south to the state line in Pelham, then joins the Merrimack River in Dracut, Massachusetts. Although impacts to the Brook itself do not vary appreciably between the two options, the West Option has lower impacts on the system as a whole (2.0 acres or 3.5 acres for the Three- and Four-Lane Alternative, respectively) as compared to the East Option (3.4 acres or 4.2 acres). Extension of the culvert in this vicinity will degrade to some degree the system's ability to provide for finfish and shellfish habitat, although this adverse effect should be limited to the footprint of the widened highway. Other functions performed by the system will be incrementally reduced, but should remain present in all cases.

Impacts to Wetland Systems 21, 22, and 23 north of Exit 4 are largely restricted to relatively minor edge impacts. Notably, direct impacts to Wheeler Pond (Wetland System 21) have been avoided. However, there are small impacts to the emergent marsh in the southwest corner of the pond (previously disturbed) and to forested wetland just to the northwest of the pond. Portions of Wetland System 22 within the existing median just north of the Pillsbury Road overpass will be lost, and the Eastern Option encroaches on two vernal pool areas within this system (Vernal Pool 20 and Vernal Pool 21, see Section 4.6.3 for a discussion of vernal pools.) However, since the majority of the impacts in Systems 21, 22, and 23 are relatively small in relation to their total size, and since these systems are already fragmented by the highway, these wetland impacts are expected to result in only small incremental losses in wetland functions and values.

Segment F

In Segment F, three construction options are proposed, all of which would result in impacts to Wetland Systems 23 through 27. In total, the Relocate Northbound Ramps option would result in greater wetland impacts (15.0 acres for the Three-Lane Alternative or 19.1 acres for the Four-Lane Alternative) than the Relocate NH 28 and Reconstruct NH 28 options (14.0 acres or 17.9 acres).

Wetland System 24 (Londonderry Central) is a relatively intact, moderately-sized forested and emergent wetland with a diverse plant community. It provides several wetland functions, including substantial wildlife habitat and sediment/toxicant retention. Of the three construction options, the relocation of the northbound Exit 5 ramps would cause the most extensive impacts to this area (3.7 acres or 4.1 acres for the Three- and Four-Lane Alternatives), which would likely eliminate or substantially impair this wetland's functions and values. Other options (Relocate and Reconstruct NH 28) have less substantial impacts (1.2 acres or 1.5 acres), and are limited to edge effects along the system's periphery.

Impacts to Wetland System 25 would be greater with the Relocate and Reconstruct NH 28 options compared to Relocate Northbound Ramps option. This wetland is among the larger and more noteworthy systems in the study corridor, providing twelve of thirteen of the standard wetland functions and values. The system is upgradient of the Little Cohas Brook system (which is located west of the highway corridor) and provides substantial wildlife habitat, finfish habitat, aesthetic value and water quality benefits including floodflow alteration. All three options would have similar impacts to portions of Wetland System 25 in the existing median and to the west of the highway. However, the Relocation and Reconstruction Options would fill portions of the scrub-shrub, emergent marsh and open water pond to the east and north of the Exit 5 interchange. These additional impacts will incrementally reduce the ability of the system to provide floodflow alteration, wildlife habitat, and finfish habitat.

North of Exit 5, the Build Alternatives all propose identical impacts to Wetland Systems 26 and 27. These tend to be relatively small edge effects. Cohas Brook (Wetland System 26), a regionally important stream and wetland complex parallels the highway corridor for nearly two miles in this northern-most portion of the project area, including flowing within the median for approximately 4,900 feet. Like Porcupine Brook to the south, this system supports a substantial red maple floodplain forest along its length. All three design options in this Segment avoid substantial impacts to this system. The largest portion of the impact to this system is associated with its southern-most forested portion that, while draining towards the Brook, is not directly adjacent to the floodplain forest. Note that the Cohas Brook itself will be impacted in two locations where the Brook crosses the northbound barrel. It is expected that the highway construction will have only a small incremental adverse impact on this system's ability to provide wetland functions and values in Wetland Systems 26 and 27.

Sound Walls

Impacts to wetlands due to construction of sound walls within the project corridor are included in the impact figure for each of the Three-Lane, Four-Lane, and Four-Lane/Three-Lane Combination Alternatives.

Park-and-Ride Facilities

New park-and-ride lots are proposed for Exit 2, 3 and 5 which would result in additional wetland impacts. Depending on which park-and-ride option is constructed, wetland impacts would vary from 0.4 to 3.2 acres. Proposed park-and-ride concepts are shown on **Figures 2.3-38, 2.3-39 and 2.3-41**.

At Exit 2, wetland impacts due to the new park-and-ride lot would amount to 0.3 acre of emergent wetland. At Exit 3, no wetlands impacts would occur due to the tight shift option park-and-ride. If the Northbound Shift Option is constructed, impacts resulting from construction of a park-and-ride lot would be approximately 0.3 acres.

At Exit 5, wetland impacts due to Option 1 would amount to 0.6 acre of forested wetland and Option 2 would result in 0.8 acre. Option 3 would result in 0.1 acre of impact whereas Option 4 would have an impact of 0.3 acre. Construction of Option 5 would result in the most impact of any of the options at Exit 5, with 1.8 acres of forested and emergent wetland impact, while the Selected Alternative would impact 1.3 acres.

Prime Wetland Impacts

As discussed in Section 3.6.1, designated Prime Wetlands are located in the Towns of Salem and Derry. Prime Wetlands are areas designated by municipalities and NHDES that are given a higher level of regulatory protection through the State wetland process than non-designated areas.

Because of their importance, direct impacts to prime wetland have been avoided through careful project design. As such, the hydrology of these wetlands areas will be maintained. In addition, no direct stormwater discharges will occur in prime wetlands. Work occurring adjacent to prime wetlands includes clearing and grading to allow widening of the highway in both towns.

4.6.2.3 No-Build Alternative

The No-Build Alternative would not have any direct construction-related impacts on wetland resources since there would be no new construction.

4.6.2.4 Secondary Impacts

Impacts associated with potential secondary growth are discussed in Section 4.12 of this document. This evaluation involved designation of a study area (i.e., an area subject to the project's influence); forecasting potential population and employment growth under both the build and no-build scenarios; interpreting how this growth

would translate into future land use changes; and finally predicting how natural resources might be affected by those changes.

The secondary impact evaluation process followed the Delphi approach, where the predictions of a panel of experts were assembled using so-called "blended averages." This approach led to a prediction that the Proposed Action could result in an additional population increase of 40,626 people and an increase of 21,527 new jobs by the year 2020, as compared to the No-Build Alternative. By extrapolation, it was further estimated that 19,356 additional acres of undeveloped land may be converted to accommodate residential development and 479-867 acres may be converted to accommodate the business growth that would create these new jobs. Using an average of 673 acres associated with business growth, the total number of additional acres that may be affected with the Build Alternative is approximately 20,100.

Using Geographic Information Systems (GIS), an analysis was also performed to determine whether the predicted growth (measured in acres) could be accommodated in each of the 23 communities in New Hampshire and six in Massachusetts without impacting sensitive resources (see Section 4.12.8). This analysis included documenting the amount of wetland, conservation land, farmland, and large unfragmented habitat tracts within each town (see Table 4.12-6).

A second part of the analysis was to document the amount of "developable land" in each town from their master plans or similar sources. The objective here was to determine whether there was sufficient space to accommodate growth within the towns with the assumption that developable land identified in planning documents had already taken into account protection of sensitive resources. This information was available for all of the Massachusetts towns, but regrettably for only six of the New Hampshire towns. For the Massachusetts communities, it was concluded that growth would occur as "infill" within already developed and appropriately zoned areas, and hence important natural resources would be protected.

Of the six communities in New Hampshire where it was possible to document the availability of developable land, five towns (Auburn, Chester, Deerfield, Derry, and Londonderry) appear to have sufficient space to grow without presumably affecting sensitive resources. The other community, Bedford, is near build-out and zoning regulations, minimum lot sizes and similar measures would have to change to accommodate future growth. The latter scenario is considered unlikely, however, and the predicted growth in Bedford appears to be over estimated (see discussion in Section 4.12.8).

With the presumption that growth in all six Massachusetts communities and five New Hampshire towns can occur without affecting sensitive resources, one can conclude that approximately 7,000 acres or 35 percent of the total 20,100 acres of additional development can occur with little or no impact on wetlands.

For the remaining 13,100 acres of land that is potentially vulnerable, a worst-case scenario was calculated for possible wetland impacts. This involved estimating (all in New Hampshire) the percentage of the landscape typically covered by wetlands and assigning that proportion of the predicted growth as representing impacts to wetlands. Two sources of information for the wetland percentages were used: Tiner and Veneman (1995) report that as much as 17.2 percent of New Hampshire originally contained hydric (wetland) soil, while Fretwell *et al*. (1996) report that as much as 10 percent of New Hampshire is currently wetland.

Using the above wetland estimates, the following worst-case secondary impacts were calculated for New Hampshire:

Table 4.6-4
Worst-Case Estimates (Acres) of Additional Wetland Losses Associated with Potential Secondary Growth by the Year 2020 under the Build Alternative.

State	Possible Additional Land Conversion	Wetland Losses Assuming Percentages Reported By	
		Tiner & Veneman (1995)	Fretwell *et al.* (1996)
New Hampshire	13,100	2,253	1,310
Massachusetts	Not Applicable – See Text		

The above estimates ignore that all wetlands in New Hampshire (as well as Massachusetts) are protected under State statutes, and in most towns by local ordinances as well and as such are subject to scrutiny and permitting. At the federal level most wetlands fall under the protection of the Clean Water Act. In New Hampshire, there is a Statewide Programmatic Program for sharing this responsibility between NHDES and the ACOE. Records kept by NHDES indicate that recently about 150 acres of wetlands per year are converted each year in New Hampshire. Between 1997 and 2002 the authorized conversion of wetlands statewide (i.e., with approved dredge and fill permits) totaled about 550 acres in New Hampshire. Offsetting this loss has been the creation of approximately 160 wetland acres and the preservation of another 3,600 acres of upland and wetland (see Section 4.12.8). In this context, some wetland loss could be expected to occur as an inevitable consequence of growth by the year 2020. This is the case with or without the project. However, this loss would be partially offset by compensatory mitigation, which is typically required for approval of wetland dredge and fill permits.

4.6.2.5 Compensatory Wetland Mitigation

In 1989, the USACOE and USEPA signed a memorandum of agreement (MOA) that established a policy consistent with a goal of no net loss of wetlands. The federal policy requires that wetland impacts be avoided, or if avoidance is not practical, then steps must be taken to minimize the impact of a project. Throughout preliminary design for this project, wetlands have been avoided through a very detailed alternatives analysis (see Section 4.6.2.2.). The alternative analysis included establishing design controls to minimize impacts to the more sensitive wetland resources. Where it was not possible to avoid wetlands, minimization was considered including the steepening of side slopes or construction of retaining walls, especially along the larger streams. During final design, these measures and additional opportunities will be evaluated and incorporated, where practicable. Elimination of the bike path has also reduced wetland impacts by about 9 acres. Where impacts occur, compensatory mitigation may be used to offset the wetland impacts. The 1989 MOA provides guidelines for USACOE and USEPA personnel when considering compensatory mitigation requirements for wetland permit applications. **Figure 4.6-2** shows the location of potential wetland mitigation sites that are being considered for this project.

In the early 1990s, based on very limited information, the wetland impacts associated with widening I-93 were estimated to be approximately 30 to 35 acres. In an effort to facilitate the permitting process and to satisfy the compensatory mitigation requirement of the MOA, the search for potential advanced wetland mitigation sites was initiated in 1995.

As agreed to by both state and federal resource agencies during discussions at several monthly Natural Resource Agency Coordination Meetings, wetland impacts incurred during previously constructed projects within this segment of the I-93 corridor are to be mitigated as part of the wetland mitigation package associated with the I-93 widening from Salem to Manchester. These projects include bridge rehabilitations and/or replacements over: Stonehenge Road and Fordway Extension in Londonderry; over NH Route 111A in Windham; over Kendall Pond Road, and North Lowell Road (Bridge Street) in Derry; over Bodwell Road, Cohas Brook and I-293 on-ramp in Manchester. Other projects include the construction of the Rest Area in Salem, and the Weigh Stations in Windham. Wetland impacts collectively amount to 4.5 acres from these projects.

In March 1999, a Public Hearing was held to consider the merits of going forward with the development of two advanced wetland creation sites: the South Road Mitigation Site in Londonderry (formerly known as L-8, L-8 Extension, and L-12) and Pelham Road Mitigation Site in Salem (S-3). At the time of the meeting, there was a consensus among the agencies that these mitigation sites would largely address the mitigation requirements relative to direct impacts to wetlands. The South Road and Pelham Road sites were accepted by the agencies and the advanced mitigation project received design approval from FHWA on June 2, 1999. Construction of the

Pelham Road Site is complete. Design of the South Road Mitigation Site is currently underway and construction is expected to commence in 2003/2004.

In August 2000, the first of several Environmental Streamlining meetings was held to initiate a process whereby agency "partnering" in advance of the EIS preparation could collectively make the complex environmental process more efficient for this important project. The I-93 widening project was the first to formally adopt agency partnering protocols that would benefit the I-93 project and potentially serve as a model for other projects.

As part of the "streamlining" process, federal and state agencies have met a number of times in various forums to identify wetland mitigation "package" components with the goal of obtaining early acceptance of an assemblage of mitigation components that would adequately compensate for wetland impacts. The mitigation package components are described at the end of this section. Also included in the following sections is a summary of the mitigation site selection process (creation and preservation), and a descriptive summary of current and proposed wetland mitigation sites. Coordination letters between the USEPA and NHDOT relative to the mitigation plan are included in Appendix J.

Advanced Wetland Mitigation Site Selection

Each of the five communities along the I-93 corridor was contacted in an effort to locate potential sites advanced for advanced compensatory mitigation. Meetings and discussions were conducted with the conservation commissions, and town or city officials to learn of potential sites that might satisfy mitigation requirements in advance of the actual I-93 widening construction. Preferably, potential advance mitigation sites would meet the following criteria:

- Have evidence of appropriate hydrology by either being adjacent to functioning wetlands, adjacent to streams or rivers, or influenced by a high water table.
- Currently disturbed or degraded, whether wetland or upland.
- Large enough to provide a minimum of 3.0 acres of mitigation area.
- Accessible and reasonably close to I-93.
- Involve wetland creation and/or enhancement, as opposed to preservation only.
- Involve publicly, versus privately, owned property.

Each potential site was subsequently field investigated by wetland mitigation specialists to discern the likelihood and cost-effectiveness of creating productive wetlands and wetlands of sufficient size. Additional factors considered during the mitigation selection process included:

- Proximity of the site to other wetlands.
- Current status of degradation of the site.
- Amount of site alteration required to create or restore wetlands.
- Quality and usefulness of the material excavated from the site.

Advanced Wetland Mitigation Sites

Based upon the aforementioned sets of criteria, two sites were proposed and approved. The Londonderry site is currently being designed and the Salem site has been constructed. Characteristics and attributes of these sites, known as the South Road Mitigation Site, and Pelham Road Mitigation Site, are described below. See **Figure 4.6-2** for wetland mitigation site location.

South Road Mitigation Site (shown as Site #14 and 15 in **Figure 4.6-2**) is a 75-acre collection of three lots located west of the Londonderry/Derry border near the intersection of South Road and Gilcreast Road in Londonderry. The site borders Beaver Brook, which is a designated Conservation District pursuant to local ordinances in Londonderry. Large portions of two of the lots were privately-owned gravel pits until purchased by NHDOT, with the potential to become residential development. The third lot is mainly wetlands associated with Beaver Brook. Principal wetland functions and values expected to be provided by the site include groundwater recharge/discharge, fish and shellfish habitat, sediment/toxicant retention, and wildlife habitat. Situated on Map 7 of the Londonderry lot and parcel maps, the three lots are identified as: Lot 111 (24.4 acres), Lot 113 (38.0 acres), and Lot 114 (12.8 acres). An estimated 11 acres of creation and/or enhancement and approximately 64 acres of preservation will be provided by the site. Created wetland areas are currently being designed for the site. Construction of the mitigation area(s) is scheduled to begin in Fall 2003.

The main characteristics favoring use of this site are:

- Large site which could accommodate extensive mitigation needs.
- Good site access; the site is located approximately 0.8 miles west of I-93.
- High likelihood for success; Beaver Brook passes through the site.
- Portions of the site may provide important turtle nesting habitat.
- For the most part, the excavation depths should be relatively shallow.
- Groundwater monitoring data has been collected on a continual basis from a number of wells on the site.
- The site is contiguous with other wetlands and publicly-owned property.

Pelham Road Mitigation Site (Site #31) is located in Salem, west of Exit 2, south of Pelham Road, and consists of three former lots of varying dimensions totaling 24.6 acres in size. Porcupine Brook, a designated Salem Prime Wetland, passes through the site. A portion of the northern-most lot was subdivided and is occupied by a commercial skating rink. The portion of the lot used for mitigation was degraded, having served as an area for excavation and for disposal of fill materials and refuse. These portions were developed into wetlands and combined into the Porcupine Brook wetland system (for additional flood storage) with minimal site grading and excavation. Principal wetland functions and values provided by the site include floodflow alteration, sediment/toxicant retention, nutrient removal, sediment/shoreline stabilization, and wildlife habitat. The site provides about 4 acres

of creation/enhancement and about 21 acres of preservation. Construction was completed in 2001.

The main characteristics favoring use of this site were:

- The size is acceptable and could accommodate a reasonable amount of mitigation in a fairly developed area.
- The mitigation enhanced the designated Prime Wetlands associated with the Porcupine Brook Watershed.
- Good access exists to the site; the site is located within 0.5 miles of I-93.
- The site is directly located in a watershed that will be impacted by reconstruction of I-93.
- Excellent likelihood for success of the mitigation effort due to the presence of Porcupine Brook passing through the site.
- Provided additional flood storage for the town with minimal additional cost.

Additional Site Selection

With the development of widening layouts (albeit conceptual) and better estimates of potential impacts associated with widening I-93, and with the understanding that some additional mitigation would need to be considered to offset impacts to all five communities along the corridor, further investigations and discussions were begun to consider what other mitigation would be appropriate. Discussions and meetings were conducted with the conservation commissions, natural resource agencies, town or city officials, other interested individuals, and the general public to obtain recommendations and information about specific properties. Discussion with the resource agencies indicated a shift in priorities away from wetland creation and enhancement, and instead emphasized preservation of large undeveloped tracts of land.

In general, the mitigation sites which are to be considered in addition to the advanced site meet some of the following criteria:

- Are areas threatened by imminent development within communities impacted by the highway project.
- Have a mix of relatively undisturbed uplands and wetlands that provide important wildlife habitat or contain rare/threatened plant or animal communities.
- Lie adjacent to functioning wetlands, streams or rivers, or undeveloped areas, thereby providing or enhancing continuity with established wildlife corridors or greenways.

- Contain wetlands that provide similar functions and values as those impacted by proposed construction activities.
- Contain or lie adjacent to prime wetlands.
- Be large enough to provide relatively unfragmented wildlife habitat or preservation of unique communities or buffers thereto.
- Provide potential use by the public as recreational or educational areas with accessibility, i.e., areas adjacent to existing established conservation tracts with public access.

As the NHDOT received input and feedback from communities and the agencies, numerous sites were compiled and investigated between early 2001 and the spring of 2002. In all, more than 60 sites comprising 7,000 acres of land were researched, visited, and assessed by NHDOT (see Table 4.6-5). A number of field visits were jointly undertaken with the resource agencies and/or local officials. Based on NHDOT's study, a mitigation package was proposed involving 11 sites and approximately 650 acres.

Table 4.6-5
Potential Wetland Mitigation Sites

Site ID #	Site Name	Town	Approximate Total Size	Creation (acres)	Preservation (acres)	Notable Site Features
1	Cohas Avenue Site	Manchester	28.0	7.5	20.5	Old sand/gravel pit. Abuts Cohas Brook. Good wetland creation potential.
2	Demers Site	Manchester	25.0		25.0	Includes forested hillside and floodplain areas that abut Cohas Brook.
*3	Filip Farm Site	Manchester	35.0		35.0	Portion of Filip's Glen development deeded to Crystal Lake Preservation Association and other undeveloped lots. Open field and wetlands that abut Mosquito Brook and other Crystal Lake area parcels.
43	Crystal Lake Preservation Association Properties	Manchester	6.0		6.0	Forested upland and wetland areas that abut Crystal Lake and lie adjacent to Filip Farm Site.
*44	Giovagnoli Farm Property	Manchester	20.0		20.0	Agricultural field that lies adjacent to Cohas Brook and connects to Great Cohas Swamp located to west.

* These sites or a portion of these sites have been selected for the recommended wetland mitigation package.
+ These sites also provide flood storage compensation as well.

Table 4.6-5 (continued)

Site ID #	Site Name	Town	Approximate Total Size	Creation (acres)	Preservation (acres)	Notable Site Features
*46	Podsadowski Property - The Hill	Manchester	34.0		34.0	Forested, hillside parcel provides important connection to other undeveloped and protected land areas. Source of groundwater recharge for Crystal Lake.
*47	Greek Picnic Grounds	Manchester	40.0		40.0	Hill top parcel that connects Crystal Lake area parcels to existing conservation lands.
48	Hackett Hill	Manchester	140.0		140.0	Forested upland and wetland areas that abut existing nature reserve and contain wide variety of plant species and wildlife habitat.
*53	Demers Property Easement	Manchester	10.0		10.0	Conservation easement on existing undeveloped land to widen ecological corridor along Mosquito Brook.
7	Bob Evans Tree Farm	Londonderry	220.0		220.0	Wide variety of wildlife habitat including forested areas, open field, open water and vegetated wetlands.
*14, *15	South Road Mitigation+ Site	Londonderry	75.0	11.0	64.0	Advance Mitigation Site. Abuts Beaver Brook. Created wetlands and wildlife habitat restoration in design.
*58	Scobie Pond Area	Londonderry	310.0		310.0	Identified by Town of Londonderry as opportunity for preservation.
59	Reed Clark Corridor	Londonderry	91.0		91.0	Identified by Town of Londonderry as opportunity for preservation.
60	Little Cohas Brook Area	Londonderry	60.0		60.0	Identified by Town of Londonderry as opportunity for preservation.
*61	Musquash Expansion Parcels	Londonderry	372.0		372.0	Upland/wetland complex adjacent to conservation lands. Identified by Town of Londonderry as opportunity for preservation.
62	Bockes Forest Expansion	Londonderry	103.0		103.0	Identified by Town of Londonderry as opportunity for preservation.

* These sites or a portion of these sites have been selected for the recommended wetland mitigation package.
+ These sites also provide flood storage compensation as well.

Table 4.6-5 (continued)

Site ID #	Site Name	Town	Approximate Total Size	Creation (acres)	Preservation (acres)	Notable Site Features
*63	Norwood Parcel	Londonderry	33.0		33.0	Diverse wetlands adjacent to perennial tributary to Beaver Brook, make up 80% of the site which lies adjacent to conservation land.
*16	Sybiak Farm Property	Derry	198.0		198.0	Wide variety of wildlife habitat including upland forest, abandoned farm field/orchards and prime wetlands.
17	Castle Reach	Windham	382.0		382.0	Forested areas adjacent to Mitchell Pond. Under imminent development pressure.
18	Nassar Property	Windham	79.0		79.0	Hilly wooded and open terrain with trails and pond. Adjacent to Flat Rock Brook.
19	Nassar Property "Back orchard"	Windham	21.0		21.0	Active agricultural operation.
*24	Highway Median+	Windham	17.0	Possible		Located within existing highway median. Possible wetland creation and restoration. Wellhead protection district adjacent to existing NHDOT mitigation site.
*49	Armstrong Property (Cobbetts Pond Site)	Windham	11.0		11.0	Adjacent to existing NHDOT creation site. Wellhead Watershed Protection District located on site.
51	Flat Rock Brook Area	Windham	300.0		300.0	Undisturbed contiguous tract of land adjacent to Flat Rock Brook. Wide variety of species and wildlife habitat.
52	Seavey Pond Area	Windham	215.0		215.0	Forested upland and wetlands that border on Seavey Pond. Abuts existing conservation land.
54	North Flat Rock Brook Area	Windham	650.0		650.0	Forested uplands and wetlands that border Flat Rock Brook tributaries. Abuts existing conservation land.
55	Searles Area Site	Windham	102.0		102.0	Mostly forested areas with wide topographic relief.

* These sites or a portion of these sites have been selected for the recommended wetland mitigation package.
+ These sites also provide flood storage compensation as well.

Table 4.6-5 (continued)

Site ID #	Site Name	Town	Approximate Total Size	Creation (acres)	Preservation (acres)	Notable Site Features
*45	Windham Southeast Lands	Windham	950.0		950.0	Large, undisturbed, contiguous forested areas adjacent to Porcupine Brook and Golden Brook containing diversity of species and habitat. Some areas under develop-ment threat. Contains EPA-identified Heritage Site (NE Basin Swamp).
50	Brady Road Site	Salem	18.0		18.0	Private residence and forested area recently cleared. Abuts Porcupine Brook, Eismont Property and Southeast Lands Site.
*30	Cluff Crossing	Salem	27.0			Flat open fields and prime wetlands. Wetland creation/enhancement and floodplain compensation.
*31	Pelham Road Mitigation[+] Site	Salem	25.0	4.0	21.0	Advance Mitigation Site. Abuts Porcupine Brook. Created wetlands complete.
*32	Salem Wastewater[+] Treatment Plant	Salem	32.0	10-15		Abandoned buildings and plant components and second-growth areas. Flood storage compensation and hazardous waste remediation.
33	Garabedian Drive	Salem	35.0	Possible		Cleared altered areas adjacent to Spicket River. Flood storage compen-sation and possible creation/restoration.
35	Keewaydin Reality Trust Property	Salem	14.0		14.0	Forested area adjacent to Porcupine Brook (prime wetland). Flood storage compensation.
36	Public Works Garage	Salem	7.0	Possible		Agricultural field adjacent to Policy Brook. Possible flood storage compensation and/or wetland creation.
*38	Baggett Property[+]	Salem	6.0	2-3	6.0	Forested area adjacent to prime wetland. Flood storage and/or preservation (wildlife habitat).
40	Eismont Property	Salem	61.0		61.0	Forested upland and abandoned farmstead with wetlands adjacent to Porcupine Brook. Site contiguous with Southeast Lands site.

* These sites or a portion of these sites have been selected for the recommended wetland mitigation package.
[+] These sites also provide flood storage compensation as well.

Table 4.6-5 (continued)

Site ID #	Site Name	Town	Approximate Total Size	Creation (acres)	Preservation (acres)	Notable Site Features
45a	Salem Southeast Lands	Salem	64.0		64.0	Forested upland island surrounded by wetlands provides diverse wildlife habitat. Contiguous with Windham Southeast Lands.
56	Massabesic Lake/ Little Massabesic Lake Area Properties	Auburn	1100.0	Possible	1100.0	Mostly forested upland and wetland areas contiguous with Manchester Water Works properties, Massabesic Lake and the Spruce Lakes/Spruce Swamp area. Smaller areas of pasture and tree farms. Gravel pit for possible wetland creation. Preservation provides watershed protection in perpetuity.
57	Dubes Pond/Hinman Pond Area Properties	Hooksett	1500.0		1500.0	Mostly forested upland and wetland areas contiguous with adjacent Manchester Water Works properties. Northern lots abut Bear Brook State Park. Preservation provides watershed protection in perpetuity.

* These sites or a portion of these sites have been selected for the recommended wetland mitigation package.
+ These sites also provide flood storage compensation as well.

Simultaneously, the USEPA with assistance from NHDES, USFWS, Audubon Society and UNH Complex Systems Research Center undertook a study that would suggest locations of high environmental co-occurrence and value, worthy of preservation in the south central region of New Hampshire (essentially the region designated as potentially being subject to secondary impacts). The study utilized Geographic Information Systems (GIS) mapping of natural resource data, existing conservation lands, and a large unfragmented land areas, and input from local conservation commissions, environmental professionals from state and federal agencies and environmental interest groups. Locations were rated in accordance with the degree of "co-occurrence" of multiple resources in a specific area and the priorities expressed by the participants. In general, emphasis was placed on areas with important natural resources, large (500 to 1,000-acre) conservation lands, and land areas providing continuity among wildlife corridors between large unfragmented land areas. From this study, the USEPA with concurrence from USFWS, NHDES and NHF&GD proposed their own mitigation package (see Appendix J). The package would include the NHDOT's proposed sites, and in addition another eight sites totaling 2,900+ acres, as well as making funding of an unspecified amount available for the purchase of additional sites over time, and funding for technical assistance to assist communities trying to cope with rapid growth and development. It should be

noted that from the agencies' perspective, their mitigation package goes beyond offsetting the highway widenings' direct impacts to wetlands and natural areas, and provides mitigation to address the general issue of secondary impacts in the region served by I-93 (see Section 4.12).

In response to comments by the USEPA and others on the mitigation package presented in the DEIS, the mitigation proposal has been expanded. The revised package includes: 1) additional lands in the Southeast Lands area of Windham, bringing the total area to be preserved in this vicinity to 300 acres; 2) ecologically important lands adjacent to and including portions of the Musquash Swamp will add permanent protection to approximately 110 acres of land and create a reserve of approximately 820 acres including already preserved Musquash Conservation Area lands; 3) protection of approximately 70 acres in Londonderry, which will help preserve the integrity of adjacent Scobie Pond; 4) conservation and recreation easements on a 27-acre parcel in Salem acquired by NHDOT known as Cluff Crossing which will protect the confluence of Porcupine and Policy Brooks including adjacent prime wetlands, 5) preservation of an additional 37-acre parcel adjacent to Beaver Brook and the 75-acre South Road advance mitigation site in Londonderry; 6) a commitment to provide up to $3 million in funding to the NHDES Drinking Water Supply Land Grant Program for protection of lands adjacent to Massabesic Lake (the drinking water supply for Manchester and parts of Derry and Londonderry), and 7) a commitment to study the feasibility of wildlife crossings at Policy, Porcupine, Beaver, and Cohas Brooks during final design.

These revisions bring the total mitigation package to 17 sites protecting approximately 1,000 acres of land. Within these lands, approximately 26 to 34 acres of new wetlands will be created. These totals do not include the amount of land that will be protected through the $3 million in funding to be provided to the NHDES Drinking Water Supply Land Grant Program. It is also important to view the revised mitigation package in light of the overall decrease in estimated wetland impacts due to the decision to eliminate the bike path from the project. (That is, project impacts for the Preferred Alternative in the DEIS compared to the Selected Alternative in the FEIS decreased from approximately 83 acres to approximately 77 acres.)

More detail on the mitigation package is provided below.

Proposed Project Mitigation/Enhancement Package

The project mitigation/enhancement package is an attempt to address the direct impacts to wetlands and associated natural resources as result of highway and interchange construction. As previously discussed, the proposed package by NHDOT involves 17 sites and approximately 1,000 acres. The proposed package was developed under assumptions that the mitigation should:

- Primarily address direct impacts to wetlands, flood storage, and water quality.

- Be located within close proximity to project impacts, and to the extent practicable, within the five corridor communities which would absorb the majority of impacts associated with the highway widening.

- Be generally distributed within the corridor communities in accordance with the quality of the impacted resources within each community, and the overall magnitude of impact the project brings to bear on each community.

- Reflect the priorities of each community relative to mitigation with recognition of the direction provided by the Resource Agencies.

- Involve a reasonable expenditure of public funds.

Sites not proposed may either not address the needs listed above or may fall short for reasons as follows:

- Highly degraded or altered conditions.
- Comprised of nearly all wetland, therefore, unlikely to be developed.
- Comprised of nearly all upland, therefore habitat diversity is limited.
- Already protected by conservation easement or development restrictions.
- Not favored by particular agencies or concerned parties who may (or may not) have recommended alternate sites.
- Cost relative to value and/or suitability as mitigation site was exorbitant.

Specific descriptive site summaries are provided here for each component of the mitigation package. Sites are located within each of the five corridor communities: Salem, Windham, Derry, Londonderry, and Manchester **(Figure 4.6-2).**

Salem

Sites proposed in Salem all contain a flood storage component to assist with the persistent flooding problems in the town, and to mitigate for lost flood storage due to proposed highway construction. In providing for flood storage, wetland creation/enhancement will be provided with benefits in terms of wildlife and water quality. For the Selected Alternative, the total amount of wetland impacts (including the Exit 2 Park-and-Ride and sound walls) within Salem is approximately 23 acres. Total mitigation provided by the proposed sites amounts to approximately 90 acres (including creation, preservation, and flood storage replacement elements). Each of the sites is described below.

Cluff Crossing Road (Site #30) is a 27-acre parcel located adjacent to the confluence of Policy Brook and Porcupine Brook. The site provides floodplain protection and contains a prime wetland designated by the town of Salem. In discussions with the Salem Conservation Commission, protection of the Cluff Crossing parcel was identified as a high priority.

Pelham Road Mitigation Site (Site #31) is an advance mitigation site previously described. The site is approximately 25 acres in size with approximately 4 acres of wetland creation. Construction was completed in 2001.

Salem Wastewater Treatment Plant Site (Site #32) is adjacent to the Spicket River. A portion of the site lies within existing floodplain. Although cleanup of the site (hazardous materials) would be necessary, the site is ideal for its flood storage potential and additional wetland creation area. The Town of Salem is in favor of the use of this site. The site is approximately 32 acres in size with potential wetland creation of 10 to 15 acres.

Baggett Property (Site #38) is located on NH 38 adjacent to the existing highway. Although only 6 acres in size, the site could provide critical flood storage and possibly additional created wetlands (2-3 acres) to tie into existing prime wetlands located south of the site.

Windham

Sites proposed in Windham provide wetland creation in close proximity to Canobie Lake and Cobbetts Pond, locations which have little remaining buffer areas to development. Other mitigation sites (Southeast Lands) provide preservation over a large number of properties. These sites were included on "co-occurrence" maps developed by USEPA and other agencies as previously discussed. As such, the Southeast Lands site was proposed in part in response to resource agency input. For the Selected Alternative, the total amount of wetland impacts (including the Exit 3 Park-and-Ride and sound walls) in Windham is approximately 16 acres. Total mitigation provided by the sites in Windham would amount to nearly 318 acres (creation, preservation, and flood storage replacement). Each of the sites is described below.

Highway Median Site (Site #24) is located between the northbound and southbound lanes, south of NH 111A in the vicinity of Canobie Lake and Cobbetts Pond. This site is 17 acres in size and would become available with the tight shift option (Selected Alternative). Lying adjacent to a large area of emergent marsh, Site #24 would provide additional created wetland area in addition to flood storage.

Armstrong Property (Site #49) is located adjacent to an existing Windham-Salem Project Mitigation Site. As it lies in close proximity to Cobbetts Pond, the 11-acre property (under threat of development) would provide an important preservation buffer to the pond.

Southeast Lands Area (Site #45) is located primarily in the southeast corner of Windham, with a smaller portion located in Salem. The approximately 290 acres proposed for preservation represents a core section of a larger area totaling about 1,100 acres that is currently undeveloped but under the immediate threat of development. Consisting of large areas of wetland habitat interconnected with upland islands, the area provides largely unspoiled wildlife habitat, diverse plant communities, and buffering protection to forested, scrub/shrub and emergent marsh

wetlands. NHDOT has worked closely with the Conservation Commission to coordinate the proposed mitigation with the Town's preservation efforts.

It should be noted that the Town of Windham is greatly interested in the I-93 project and has specific concerns and priorities relative to project mitigation. Beyond their concerns relative to water quality impacts to Cobbetts Pond and Canobie Lake, they note the substantial impacts to commercial industrial properties due to the needed improvements to Exit 3, and the tremendous development pressure being exerted as a corridor community. Preserving open space is a key priority with benefits foreseen relative to water quality, wildlife, recreation, limiting the tax burden, and general quality of life issues.

Derry

The site in Derry is a large preservation site of importance to the town and is under immediate threat of development. A mix of varied upland habitat (forested, open fields) and prime wetlands (emergent marsh, forested), the site provides an extensive area for use by wildlife. Continued public use of the site (via the abandoned railbed that bisects the property and serves as a recreational trail) was indicated as an important factor to the town. For the Selected Alternative, the total amount of wetland impacts (including sound walls) in Derry is approximately 5 acres. Total mitigation provided by the site in Derry would amount to nearly 200 acres (preservation). The proposed mitigation site is described below.

Sybiak Farm Property (Site #16) is located east of I-93, and north of the Windham/Derry municipal boundary. The nearly 200-acre site consists of abandoned pastures and orchard, with mature forests situated on knolls. Extensive areas of emergent marsh and smaller areas of forested wetland provide a varied habitat for wildlife. Used recreationally by townspeople, with access provided to the site via an old rail corridor, the site is under imminent threat of development.

Londonderry

The sites proposed in Londonderry provide wetland creation adjacent to Beaver Brook and preservation of wetland and upland habitat adjacent to other conservation lands. The selected sites were determined with input from the Town and in recognition of the direct impacts in Londonderry. For the Selected Alternative, the total amount of wetland impacts (including the Exit 5 Park-and-Ride and sound walls) in Londonderry is approximately 26 acres. Total mitigation provided by the sites would amount to nearly 290 acres. The sites have also been identified as potential locations for passive recreational use by townspeople.

South Road Mitigation Site (Site #14 and 15) is an advance mitigation site previously described. The site is approximately 75 acres in size. Within this, approximately 10 to 12 acres of wetlands will be created.

Norwood Site (Site #63) is a 37-acre parcel lies adjacent to the South Road Mitigation Site and provides additional protection to the Beaver Brook wetland system. The site is a diverse mix of wetlands (forested, scrub-shrub and emergent) adjacent to a perennial tributary to Beaver Brook. Wetlands comprise 80percent of the site, which lies adjacent to state and town conservation land.

Musquash Expansion Parcels (Site #61) comprises four large blocks of land in the vicinity of the Musquash Swamp Conservation Area, and is part of a relatively large, unfragmented forest. Of this available land, the NHDOT proposes to acquire three parcels involving approximately 110 acres for land preservation. Overall, the parcels are highly diverse, with stands of mature mixed hardwoods, pine/oak forests, hemlock forests and red maple swamp, as well as emergent marsh habitat on the parcels. Although the sites border the swamp, they are largely uplands on moderately to excessively well-drained outwash soils. Given the relative intactness, diversity of landforms and vegetation, and the large size of the undeveloped land associated with the Musquash Swamp, this area is very valuable as wildlife habitat. The additional preservation will add a reserve of approximately 820 acres including already preserved Musquash Conservation area lands.

Scobie Pond Area Properties (Site #58) are approximately 70 acres of mature, intact oak/pine forest, on shallow soils with bedrock outcroppings, stands of mixed deciduous hardwoods and a red maple swamp that occupy central portions of the site. The site is largely intact, and is well utilized for passive recreation. The conservation of these parcels will add substantially to the protection of the adjacent Scobie Pond.

Manchester

The sites in Manchester provide wetland and habitat protection on lands adjacent to Crystal Lake. Under the Selected Alternative, the total amount of wetland impacts (including sound walls) in Manchester is approximately 5 acres. Total mitigation provided by the sites in Manchester would amount to about 120 acres of preservation. The proposed mitigation sites are described below.

The City, both through a local lake association and through city officials, has voiced strong support for preservation of undeveloped properties in the area of Crystal Lake. Preservation of such properties would benefit the Lake in terms of water quality and provide some open space for wildlife utilizing the Cohas Brook area as a wildlife corridor. Based on comments received on the DEIS, the mitigation package has been revised and no longer includes the Cohas Avenue site or the Demers site. These changes were made in order to focus the Manchester mitigation efforts on land around Crystal Lake.

Crystal Lake Area Properties (Site #3, 44, 46, 47, and 53) are located to the north, west, and south of the lake. Some of the properties abut the lake providing important buffering functions to the lake. The properties are contiguous with one another and

would provide a wildlife corridor extending from Crystal Lake to Great Cohas Swamp. With a variety of wetland and upland habitats, preservation of these areas would preserve many of the functions and values lost in other wetlands due to highway construction. The approximately 120 acres (all parcels combined) are more suitable as preservation properties than wetland creation. Preservation of these remaining Crystal Lake parcels is a top priority of the Crystal Lake Preservation Association and has been endorsed by the Manchester Board of Aldermen.

Additional Mitigation/Enhancement Measures

In addition to the sites described above, other measures to provide project mitigation and enhancement are proposed. These include:

- The NHDOT will provide funding not to exceed $3 million to the NHDES Drinking Water Supply Land Grant Program to be used to purchase property rights to aid in the protection and long-term viability of Massabesic Lake, the water supply for Manchester and portions of Derry and Londonderry.

- A commitment to study the feasibility of reconstructing existing culverts at Policy Brook and Porcupine Brook in Salem, Beaver Brook in Derry and Cohas Brook in Manchester to address wildlife crossing issues. These measures will be fully evaluated as part of the final design of the Selected Alternative. To the degree that these measures are practical, they will be constructed.

4.6.2.6 Wetlands Finding

Under Executive Order 11990, Federal actions (in which impacts to wetlands are unavoidable) require a "finding" that there are no practical alternatives to the proposed construction in wetlands and that the proposed action included all practical means to reduce harms to wetlands.

The project has been carefully studied with respect to its effects on wetlands. All of the Build Alternatives involve unavoidable impacts to wetlands. Direct wetland impacts resulting from the Selected Alternative total approximately 77 acres. In general, the proposed highway improvement follows an existing corridor. As such, the bulk of the direct wetland impacts are along the edge of wetland systems that have already been impacted by previous highway construction. In most cases, these "edge impacts" represent only a small percentage of the total wetland acreage within a system and, while representing an incremental loss of wetland area, will not eliminate the functions and values performed by the remaining wetland.

Mitigation for wetland impacts followed a sequential approach of 1) avoidance, 2) minimization, and 3) compensation. Avoidance of wetland impact was a primary concern in the screening of alternatives.

A project mitigation and enhancement package involving protection of approximately 1,000 acres at 17 sites throughout the study corridor will offset

wetland impacts. Even more acreage will be protected through the $3 million in funding to be provided to the NHDES Drinking Water Supply Land Grant Program. This significant land protection effort, in combination with the commitment to provide funding to communities for planning technical assistance to help them address future growth pressures (see Section 4.12), reduces the overall project impacts to an acceptable level. The NHDES, the NHF&GD and the USACOE have all found the mitigation proposal acceptable and the USEPA has indicated that they do not object to the project mitigation package.

Based on the above considerations, it is determined that there is no practicable alternative to the proposed construction in wetlands and that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use.

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4.6.3 Vernal Pools

Impacts to vernal pools are associated with both the Three-Lane and Four-Lane Alternatives. More specifically one vernal pool (VP13) would be filled to some extent by both alternatives (Three-Lane and Four-Lane). Two additional vernal pools (VP20 and VP21) would be impacted (or not) to varying amounts depending on which alternative is constructed.

Other than VP 13, adjacent upland habitat is largely unaffected by the highway widening activities. Most vernal pool and upland habitat appears to be located at least 200 feet from the edge of the roadway. All impacted vernal pools are located within existing mapped wetlands. The areal extent (acres) of impacts to wetlands, in which the vernal pools are located, is described in Section 4.6.2.

4.6.3.1 Impact Methodology

Impacts to vernal pools were determined by overlaying the alternative designs on a map showing field-reviewed wetlands and biological resources (**Figure 3.6-4**) to determine whether an area would be impacted or not. Specific (numbered) vernal pools identified as being impacted by the project are listed for both the Three-Lane and Four-Lane Alternatives by segments, A through F.

4.6.3.2 Build Alternatives

Impacts associated with each Build Alternative are described below by highway segment.

Three-Lane Alternative

Segment A

There are no vernal pools located within Segment A. Therefore, no impacts would occur due to construction of the Three-Lane Alternative in these segments.

Segment B

There are no vernal pools located within Segment B. Therefore, no impacts would occur due the Three-Lane Alternative in Segment B.

Segment C

There are no vernal pools located within Segment C. Therefore, no impacts would occur due the Three-Lane Alternative in Segment C.

Segment D

All Exit 3 options (1 through 9) in Segment D for the Three-Lane Alternative will impact one vernal pool (VP13), located within the highway median. The Three-Lane Alternative results in approximately 750 square feet, or fifty percent of the areal extent of the pool being filled. Loss of fifty percent of vernal habitat would have presumed loss of fifty percent of the breeding capacity of the vernal pool. Sufficient area exists adjacent to the pool to allow construction of lost habitat. Vernal Pool 13 has limited use by breeding amphibians, probably due to inadequate upland habitat around the pool, and apparent water quality degradation. Vernal pools VP6, VP15a, VP18, and VP22 (all located within Section D) will not be impacted by the Three-Lane Alternative options.

Segment E

Impacts to VP20 and VP21 will occur with the east option of the Three-Lane Alternative. This design option results in impacts to the western edges (that currently exhibit signs of habitat degradation, i.e. filamentous algae, trash) of the pools amounting to approximately 2,000 square feet, or twenty percent of VP20 and 1,000 square feet, or five percent of VP21 being filled. As conceptually designed, the proposed detention basin to be located between VP20 and VP21 is not expected to have a direct effect on the functioning of the vernal pools. Drainage from the basin will not be directly discharged into either vernal pool. Construction of the basin would not appear to present a physical barrier to vernal pool species. In addition, upland habitat is extensive in the areas adjacent to the vernal pools, so construction of the basin would entail little loss of habitat. With the west option, no impacts to vernal pools would occur, although the west option would have impacts to wetlands located on the west of the highway.

Segment F

There are no vernal pools located within Segment F. Therefore, no impacts would occur due the Three-Lane Alternative in Segment F.

Four-Lane Alternative

Segment A

There are no vernal pools located within Segment A. Therefore, no impacts would occur due to construction of the Four-Lane Alternative in these segments.

Segment B

There are no vernal pools located within Segment B. Therefore, no impacts would occur due the Four-Lane Alternative in Segment B.

Segment C

There are no vernal pools located within Segment C. Therefore, no impacts would occur due the Four-Lane Alternative in Segment C.

Segment D

Options (1 through 9) for Exit 3 will impact one vernal pool (VP13), located within the highway median under the Four-Lane Alternative. The Four-Lane Alternative results in approximately 1,350 square feet, or ninety percent of the areal extent of the pool being filled. Impacts to this extent would likely eliminate the functioning of this area as a vernal pool. Remaining portions of the pool could be extended in adjacent area to the west to recreate vernal pool habitat (see Section 4.6.2.4). Vernal Pool 13 has limited use by breeding amphibians, probably due to inadequate upland habitat around the pool and water quality degradation. Vernal pools VP6, VP15a, VP18,and VP22 (all located within Section D) will not be impacted by the Four-Lane Alternative options.

Segment E

Impacts to VP20 and VP21 will occur with the east option of the Four-Lane Alternative. This design option results in impacts to the western edges (that currently exhibit signs of habitat degradation, i.e., filamentous algae, trash) of the pools amounting to approximately 3,000 square feet, or thirty percent of VP20 and 3,000 square feet or fifteen percent of VP21 being filled. With the west option, no impacts to vernal pools would occur, although the west option would have impacts to wetlands located on the west of the highway (see Section 4.6.2).

Segment F

There are no vernal pools located within Segment F. Therefore, no impacts would occur due the Four-Lane Alternative in Segment F.

Four-Lane/Three-Lane Combination

A third alternative is the combination of 4 lanes beginning at the state line and extending through Exit 3 and then switching to 3 lanes after Exit 3 to the I-93/I-293 split in Manchester. Since the same vernal pools are affected by Three-Lane and Four-Lane Alternatives, the Four-Lane/Three-Lane Combination would affect the same vernal pools as either alternative constructed separately (i.e., one pool in Segment D, and none or two pools depending on whether the west or east widening option is selected in Segment E).

Sound Walls

The construction of sound walls will not impact vernal pools within the project corridor.

4.6.3.3 No–Build Alternative

The No-Build Alternative would not affect vernal pools since there would be no new construction.

4.6.3.4 Mitigation

All impacted vernal pools are included within mapped wetland areas within the corridor. Mitigation for impacts to vernal pools is discussed in Section 4.6.2.5 (Compensatory Wetland Mitigation).

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4.6.4 Wildlife Resources

4.6.4.1 Short-Term versus Long-Term Impacts

Highway construction has both short-term and long-term impacts on wildlife habitats and populations. Short-term impacts are directly related to disturbance caused by construction activities and include the construction footprint, as well as increased noise and visual disturbance from land-clearing, earth moving, construction machinery, and the presence of humans. Long-term impacts include the permanent loss of wildlife habitat, and can involve, in the case of new roads on new location, long-term changes in the availability and types of habitat, including loss of connectivity between types and increasing fragmentation of large habitat blocks.

Direct mortality due to construction impacts will most likely occur for fossorial (burrowing) mammals, reptiles and amphibians, and breeding animals and their young, whose dens or nests are destroyed by the clearing and grading. More mobile

animals may move to other habitats when disturbed by construction. These animals may find habitat that has sufficient food and cover to support them if adjacent habitats are not already at carrying capacity. Those animals that are unable to locate sufficient food, cover or space may fail to breed successfully, be forced to wander further, or eventually die.

Noise and Disturbance

Many animal species habituate to continuous noise, including traffic noise from highways; however, sudden loud noises, such as construction noise, can be more of a disturbance (Busnel 1978). Wildlife using habitats near I-93 are tolerant of traffic noise, but could be sensitive to construction noise and activities. Loud noises associated with construction could mask territorial vocalizations of species living near the highway, at least temporarily interfering with breeding (Busnel 1978).

Sudden changes in habitat types and quality due to construction can have important effects on wildlife, especially if these changes occur during critical periods. Disturbance of breeding habitat during the breeding season and while young are being reared can reduce or prevent successful reproduction. Disturbance during severe winter weather may force wildlife from protective cover which can result in lower reproductive rates and increased mortality.

Studies have shown that some species of birds, including blue jay, winter wren, Nashville warbler, bay-breasted warbler, blackburnian warbler, and savannah sparrow (Ferris 1977, Adams and Geis 1981), and some mammals, such as red-backed vole and fisher (Palman 1977), tend to avoid habitats adjacent to highways. Others are attracted to the roadside vegetation or the highway opening and tend to occur more frequently near a highway than in the adjacent forests. These species include: American robin, chestnut-sided warbler, common yellowthroat, eastern meadowlark, white-throated sparrow, indigo bunting, red fox, coyote, rabbit, and woodland jumping mouse (Ferris 1977; Palman 1977; Michael 1975, and Adams and Geis 1981). Other species may be temporarily attracted to the roadside edge for opportunistic reasons such as salt (deer and moose) or road kills (crows and vultures).

Home Range Impacts

Impacts to amphibians, reptiles and small mammals would be anticipated since these species generally have small home ranges, which may be totally eliminated with highway widening. Potential impacts to medium-sized and large mammals would generally be less severe due to the larger home ranges associated with these species and their ability to move to other habitats nearby. However, in those cases involving reduction in habitat connectivity, the impacts may make such movements difficult with long-term effects on the local population's viability.

Wildlife/Vehicle Collisions

Increasing the number of highway lanes can increase wildlife mortality due to potential collisions with vehicles as animals attempt to cross a wider highway. The ease with which some wildlife can cross a highway also varies with median widths. Wide medians can provide a refuge for individuals attempting to cross multiple highway lanes. Nonetheless, highway mortality is generally not a threat to species' populations levels (Leedy and Adams 1982) except when populations are already low or when the highway is near a critical habitat. Breeding amphibians like mole salamanders and wood frogs require vernal pool areas for breeding and any widening that makes migration to these habitats more difficult may have serious consequences on the local populations. In general, vehicle collisions with larger species of wildlife, like deer and moose, pose a far greater risk to human safety than to the wildlife populations.

Subsequent to publication of the DEIS, additional analysis of impacts due to wildlife/vehicle collisions was conducted. NHDOT does not keep any formal data on the number of roadkills or vehicle-wildlife collisions along this section of I-93. Both NHDOT's District Five highway maintenance staff and members of NHF&GD's warden service were contacted for any additional informal information on roadkills in the highway corridor. District Five highway maintenance staff reported the following observations of typical vehicle-wildlife collisions (Table 4.6-6) along the project corridor (H. Morrill, Highway District Engineer, memo dated March 26, 2003).

Table 4.6-6
Observations of Wildlife Mortality by Highway Segment

Highway Segment	Station Numbers	Wildlife Species			
		White-tail Deer	Beaver	Rabbit (Unknown Species)	Turtle (Unknown Species)
MA Line – Exit 1	1000 - 1095	----------	----------	(No Observations)	----------
Exit 1 - 2	1095 - 1160	√	√	√	
Exit 2 - 3	1160 – 1215	√			
	1215 - 1225	√			√ (Salem-Windham town line, NB only)
	1225 - 1310	√			
Exit 3 - 4	1310 - 1360	√			
	1360 - 1370	√			√ (south of Windham Weigh Station SB only)
	1370 – 1468	√			
	1517 – 1610		√		
Exit 4 – 5	1610 – 1805	√	√		
Exit 5 - I-293	1805 – 2003		√		

Interviews with NHF&GD's warden staff also disclosed that on average 50-60 deer per year are killed along I-93 between Salem and the I-293 split. The number by mid-year 2003 was ahead of average with about 30 already recorded to date (D. Walsh, pers. communication, June 20, 2003). Approximately 2-3 moose are also hit by vehicles generally in the area adjacent to the powerline corridor (Stations 1715-1735) between Exits 4 and 5 in Londonderry. Beaver remains are also frequently seen, while fisher are less commonly observed (D. Walsh, ibid.).

Several conclusions can be made from the above observations. Records for beaver generally coincided with the presence of extensive wetlands and large streams that cross under the highway in particular segments. Turtles of unknown species were also most frequently observed south of the Windham weigh station on the southbound barrel where open-water wetlands are adjacent to the road, and on the northbound barrel primarily near the Salem/Windham town line adjacent to Canobie Lake. In comparison, deer were seen primarily in areas bordered by a mix of agricultural land and forest between Exit 1 and the Windham weigh station and between Exits 4 and 5. This conclusion agrees with the local game warden's observation that deer crossing the highway is unrelated to the presence of a riparian corridor. Deer-crossing signs are located in two locations along the highway on both the northbound and southbound sides: just south of the weigh stations and between Exits 4 and 5. The observation of roadkilled rabbits between Exits 1 and 2 may be due to the presence of shrubland and more open-type habitats in that highway segment.

Travel Corridors

Riparian corridors, i.e., areas along streams or other water bodies, are important wildlife habitats and are often used as travel corridors as evidenced by the above cited observations. These are areas where it makes the most sense to focus on investigating possible wildlife crossing measures. Noss (1987) noted that riparian corridors help to maintain the natural connectivity of habitats that would otherwise be fragmented by development.

Since publication of the DEIS, all major stream crossings in the project corridor were examined to determine if existing culverts or bridges could be re-designed or improved to at least facilitate wildlife movement under the highway. These crossings included the major box-culverts for Cohas Brook, Beaver Brook, and Porcupine Brook. The two culverts carrying Policy Brook under the entrance and exit ramps to the rest area south of Exit 1 were also examined. In all cases, the existing openings were inadequate to provide a dry-land crossing for terrestrial mammals traveling along the stream's banks. These structures will be further examined during final project design to see if a "shelf" or similar enhancement can be incorporated to provide a dry-land passage for wildlife. Increasing their span length will also be considered.

All the remaining perennial stream crossings were also examined, but because of their size were reviewed primarily for potential fish passage problems. The findings of that analysis are included in Section 4.4.2 – Aquatic Life Impacts.

Summary

In commenting on the DEIS, NHF&GD stated that it "recognizes that the improvements, involving for the most part the widening of an existing interstate facility, are of less consequence to wildlife and fishery resources than would otherwise be the case with the construction of a brand new facility on new location. As such, fragmentation of the wildlife habitat is not an issue. The acreage of impact is substantial, but given that the area of impact is directly adjacent to an existing interstate facility, the wildlife, wetlands, and habitat resources are of lesser quality or only peripherally affected by the widening" (see Response #2 to Letter S-1 in Volume 3).

Of the various ways highways and their construction can adversely affect wildlife, the widening of a freeway would have less impact than the original construction of the facility. Widening projects typically impact edge areas of previously disturbed wildlife habitat. As such, the issues of fragmentation, severing of wildlife corridors, separating breeding areas from non-breeding areas, etc. are typically of less concern with highway-widening type projects. Of concern with a widening type project are additional impacts to sensitive habitat areas and potential increases in road kill. Areas where such concerns potentially exist along the project corridor include the heron rookery north of Exit 3, adjacent to the vernal pools lying just off the edge of the highway, and at major stream crossings where medium to large mammals in particular may attempt to go up and over the highway.

The amount of direct habitat loss varies among the various project alternatives and options. These differences can be used as one measure of the relative merit of each option or alternative. The following section describes the direct habitat impacts resulting from construction of the project. Secondary impacts due to future induced development are discussed in Section 4.6.4.4.

4.6.4.2 Build Alternatives

The percentage of each major cover type or land use along the corridor was estimated by visual inspection: wetlands 20 percent, upland forest and shrubland 30 percent, agriculture 10 percent, mowed highway edge 15 percent, and residential or commercial development 25 percent (**Figure 3.11-1**, Land Use). These average percentages were used to estimate the amount of habitat directly affected by the proposed improvements.

Three-Lane Alternative

Depending on the various options selected for the interchange configurations and other design choices, the Three-Lane Alternative will convert approximately 170 to 220 acres of land outside the existing right-of-way. Useable wildlife habitat in the form of wetlands, upland forest and shrubland, and agricultural fields or orchards make up an estimated 60 percent (102 to 132 acres) of the total conversation.

The total area of disturbance both inside and outside the State's existing right-of-way for the Three-Lane Alternative is estimated to be 275 to 350 acres. The direct loss of wetland habitat will range from 55 to 70 acres (see Section 4.6.2). Upland habitat disturbance (i.e., upland forest, shrubland and agriculture) will be on the order of an additional 110 to 140 acres.

Four-Lane Alternative

Depending on the various options selected for the interchange configurations and other design choices, the Four-Lane Alternative will convert approximately 225 to 290 acres of land outside the existing right-of-way. An estimated 60 percent (135 to 175 acres) of this is useable wildlife habitat, i.e., wetland, upland forest and shrubland, or agriculture.

The total area of disturbance both inside and outside the State's existing right-of-way for the Four-Lane Alternative is estimated to be 300 to 375 acres. The direct loss of wetland habitat will range from 60 to 75 acres (see Section 4.6.2). Upland habitat disturbance will be on the order of an additional 120 to 150 acres.

Four/Three-Lane Combination Alternative

A third alternative is the combination of widening to 4 lanes beginning at the state line and extending north through Exit 3 and then switching to 3 lanes after Exit 3 to the I-93/I-293 Interchange split in Manchester. The total area of disturbance is estimated to be 300 to 350 acres with this alternative. Of this total, approximately 60 to 70 acres will be wetland impacts and 120 to 140 acres upland habitat impacts.

Park-and-Rides

Additional impacts on wildlife habitat with the proposed park-and-ride lots will range from about 27 to 30 acres depending on the locations chosen.

Sound Wall

The sound wall placements will have no appreciable effect on wildlife habitat in the project area, but may serve as a barrier to movements of animals across the highway. None of the barriers is situated at any known important travel corridor locations, however.

4.6.4.3 No-Build Alternative

The No-Build Alternative will not result in any new impacts on wildlife resources, since there would be no new construction.

4.6.4.4 Secondary Impacts

The method used to evaluate secondary impacts of the project is described in detail in Section 4.12. Additional discussion as it relates specifically to wetlands was provided above in Section 4.6.2.4. This impact analysis predicted that the project could result in an additional population increase of 40,626 people and an increase of 21,527 new jobs by the year 2020 when compared to the No-Build Alternative. By extrapolation, it was then estimated that 19,356 additional acres of undeveloped land may be converted to accommodate the associated residential development and potentially another 479-867 acres for the business growth as compared to the No-Build condition. Using the mean number of acres associated with the business growth, the total number of additional acres that may be affected with the Build Alternative was estimated to be about 20,100.

As explained in Section 4.6.2.4, approximately 13,100 acres of the total 20,100 acres are at risk with the conservative assumption that sensitive resources like wetlands, large tracts of unfragmented habitat, farmland, and conservation lands will remain unprotected in the 18 New Hampshire communities that do not presently have formal plans for their community's growth. Of this total, some 1,300 to 2,300 acres of wetland could be affected with the remaining 11,000 to 12,000 acres of upland habitat developed as a consequence of secondary growth. As previously stated, these growth projections and land use impacts are highly speculative and strongly influenced by locally controlled land use regulations and policies.

In addition to this direct loss of habitat, fragmentation of habitat blocks is an issue wherever development breaks up large tracts of undisturbed land and severs wildlife corridors linking them. In contrast, conversion of small blocks of habitat is less of an issue (although still important) when they are totally surrounded by development such as in urban landscapes. Without site-specific information as to where induced development will take place, it is nearly impossible to provide any substantive elaboration of the extent or significance of habitat fragmentation.

4.6.4.5 Mitigation

A number of measures are available to mitigate for impacts to wildlife resources. The culverts and bridges at the major stream crossings (i.e., Cohas Brook, Beaver Brook Porcupine Brook and Policy Brook) will be examined in final design to determine how dry passage for mammals can be incorporated into the structures. Where appropriate,

culverts will be replaced with one's having larger openings, and natural stream bottoms created within them. Culvert crossings for smaller perennial streams will also be examined to ensure there are no accidental blockages (e.g., debris dams, perched culverts) to wildlife or fish movements. Data will also continue to be collected by District Five highway maintenance staff on the frequency of wildlife–vehicle collisions so that this information can be used to decide whether additional signage or fencing along the highway could effectively lessen the problem.

Direct habitat losses, in particular to wetland, will be offset through compensatory mitigation in the form of creation of wetlands and land preservation (see Section 4.6.2.5). Over the long term, preserving relatively large parcels of land would be more beneficial than actively creating numerous small, roadside mitigation areas. An important goal of the project mitigation is to replace the wildlife functions of impacted wetlands. Construction plans for wetland creation will attempt to maximize the diversity and interspersion of wildlife food and cover. Such steps have been incorporated into the design of the advanced wetland mitigation sites in Salem (Pelham Road) and Londonderry (South Road). A diverse group of native wetland plant species will be planted where appropriate to create a high structural and plant species diversity attractive to a wide variety of wildlife. An important criterion in the selection of preservation sites to be included in the proposed mitigation was the presence and quality of wildlife habitats and their general contiguousness with adjacent undeveloped or protected properties to create larger, unfragmented blocks. The opportunity to manage, as appropriate, portions of these preservation sites in diverse successional stages, such a grassland/old field or forested areas, will also be present. The additional preservation of critical habitats, like vernal pools and their surrounding uplands, on the mitigation parcels will have a substantial benefit to wildlife as adjacent areas are continually threatened with development.

Several measures will be taken during actual construction to further reduce impacts on wildlife habitat. The amount of land cleared of vegetation will be limited as practical. This will be important in areas where there are currently only narrow buffer strips between the highway and other human development. Re-vegetation of the land disturbed by construction activities will take place as soon as possible after construction is completed, so that erosion is minimized, and in doing so wildlife habitat and other values will be restored. Brush clearing or tree thinning in forests adjacent to the construction areas will not be proposed. Where feasible and safe, snags (i.e., dead standing trees) will be maintained adjacent to the mowed sections of the right-of-way in order to provide perch sites, nesting cavities, and den sites for wildlife.

Maintenance of the highway right-of-way to provide clear zone areas will be limited to the degree practical. Maintaining large swaths of open areas are expensive and not beneficial to wildlife and need to be balanced with providing clear zones for motorist's safety and discouraging wildlife from approaching the highway.

4.7 Threatened and Endangered Species

Based on information provided by the New Hampshire Natural Heritage Inventory (NHNHI), the NHF&GD, the USFWS and the NH Audubon Society, one population of a state-listed threatened plant may be affected by the project, as discussed below.

■

4.7.1 Plants

4.7.1 Federal Endangered and Threatened Plant Species

While four federally listed threatened or endangered plant species occur in New Hampshire, no known populations are located within the study area. Therefore, no federally listed endangered or threatened plant species will be affected by any of the proposed project alternatives.

4.7.1.2 NH Endangered and Threatened Plant Species

One population of the perennial wildflower wild lupine (*Lupinus perennis*) is located within 15 feet from the travel lane on the west side of I-93 between Exits 1 and 2 within the currently maintained right-of-way. The population is relatively small, with eight small colonies present in the open area between the roadway and an adjacent wooded area. This plant, listed by the NHNHI as a state-threatened species, is found at only 28 known sites in New Hampshire. Although considered rare in New Hampshire, this plant species is globally secure since it is demonstrably widespread and secure throughout its larger range, which extends throughout the northern plains to eastern Minnesota and south along the Atlantic Coast to Virginia. The plant is noteworthy because it is the sole larval food source for the federally listed endangered Karner Blue Butterfly (*Lycaeides melissa samuelis*), which is now thought to be extirpated from New Hampshire. Note that there is no known Karner Blue habitat in the vicinity of the lupine population.

Methods to mitigate impacts to this population are discussed in Section 4.7.3 below.

■

4.7.2 Wildlife

4.7.2.1 Federal Endangered and Threatened Wildlife Species

Based on information received from the USFWS, nine wildlife species are federally listed as endangered or threatened in New Hampshire. With the exception of occasional, transient threatened bald eagles (*Haliaetus leucocephalus*), however, no known populations occur within the project area. In their review of the project, the USFWS expressed the opinion that the project would have no direct effects on eagles (M. Bartlett, USFWS, letter dated June 12, 2002; Appendix E).

The New England cottontail (*Sylvilagus transitionalis*) is not currently listed, but is identified by the USFWS as a conservation concern and therefore a candidate for listing (M. Bartlett, USFWS, letter dated June 12, 2002; Appendix E). As discussed in Section 3.7, a field investigation of this species was conducted during the winter and spring of 2003. This investigation did not locate any populations of New England cottontail within the study corridor or the proposed mitigation sites, despite surveying all potential suitable habitat. The final report (Litvaitis et al. 2003) concluded that "(T)he planned widening of I-93 in southern New Hampshire will have limited influence on the status of New England cottontails in this portion of their current range. Remnant population in the region may be enhanced if a portion of the mitigation lands are managed in native shrubland or early successional forests".

4.7.2.2 NH Endangered and Threatened Wildlife Species

Correspondence from the NHNHI (Appendix E) identifies the eastern hognose snake (*Heterodon platyrhinos*) as the only known state listed wildlife species in the project vicinity. As discussed in Section 3.7, the location of this population is within 600 feet of the project. In addition, preliminary reports and analysis suggest that suitable hognose habitat may be located within the study corridor. Due to the difficulty of surveying for this species in the wild, an accurate assessment of project impacts is difficult. In consultations with the NHF&GD in the summer of 2003, it was determined that impacts to the eastern hognose snake cannot be entirely ruled out due to the fact that potential habitat appears to occur within the highway corridor. Therefore, to limit potential impacts, several measures are outlined in Section 4.7.4.3 below.

■

4.7.3 Secondary Impacts

Without site-specific information on where future development will occur and because threatened and endangered species locations are not well known, it is impossible to provide a meaningful prediction of potential secondary effects of growth on these species. Some loss of suitable habitat is likely to occur, even though these habitats may or may not be currently occupied (see also Section 4.6.4.4).

■

4.7.4 Mitigation

4.7.4.1 Wild Lupine

Only the No-Build Alternative avoids direct impacts to the population of wild lupine located near Exit 2. Because of its close proximity to the traveled way, all of the Build Alternatives will completely impact this population.

Efforts to mitigate for this impact will focus on relocating these individuals by means of re-seeding or transplantation. To effectively accomplish this, a written mitigation plan specific to this population will be completed in consultation with the NHNHI prior to construction. This plan will address: information on the biology and environmental requirements of wild lupine, an evaluation of other transplantation attempts in the northeast, possible collection of seed material from this population, timing and methods for the relocation, and selection of the transplant location.

4.7.4.2 New England Cottontail

Although the Selected Alternative will not have any known effect on the New England cottontail, lands selected for preservation as part of the mitigation and project enhancement package were chosen with the goal of preserving a high diversity habitat types, including early successional stages like shrubland, that are preferred by this species.

4.7.4.3 Eastern Hognose Snake

To assess and minimize impacts to eastern hognose populations, a preconstruction study of potential habitat using GIS-level analysis and/or other means will evaluate a sample of known occupied habitats within southern New Hampshire to determine their characteristics. This effort will be conducted in conjunction with the NHF&GD and will help identify potential habitat areas that might be affected by the Selected Alternative. The diversity of habitat types preserved with the project mitigation and enhancement package will also benefit this species and preserve the opportunity for further habitat management by others as appropriate.

Through a cooperative effort of NHDOT and NHF&GD, contractor personnel will be trained to recognize the hognose and be informed of its protected status. Procedures for reporting occurrences of the snake will be established to ensure proper response and reporting of the snake if encountered during construction.

4.8 Noise Impacts

The noise analysis predicted future sound levels for approximately 1,050 receptor locations in the study area, using the noise contour maps. These receptor locations included residential and commercial properties. This analysis predicted changes in sound levels from the existing conditions to the 2020 No-Build and Build conditions.

■

4.8.1 2020 No-Build Alternative

The receptor locations along the existing I-93 corridor are predicted to experience 2020 No-Build Alternative peak sound levels that are similar to the existing conditions. This is the case because the highest sound levels are generated by the combination of traffic volumes, vehicle speeds, and truck percentages. While traffic volumes will increase over time, higher volumes will result in lower vehicle speeds. Therefore, the optimum combination of traffic volumes, vehicle speeds, and truck percentages that generates the highest roadway sound levels in the future will be similar to the sound levels being generated today. There may be more hours with the peak period sound levels, but the actual sound levels will be similar to the existing conditions.

The 2020 No-Build Alternative sound levels will vary from 48 to 71 dBA. Table 4.8-1 presents the predicted sound levels for 2020 No-Build Alternative.

■

4.8.2 Alternatives Evaluated

Chapter 2 presents a discussion of the evaluation of alternatives that were considered and presents the alternatives that were recommended for further evaluation. The noise analysis is based on I-93 being widened to four lanes in each direction, which is the preferred alternative and represents a worst case condition. The alternative to widen I-93 to 3-lanes in each direction would result in only a moderate reduction in noise levels with few if any modifications to the recommendations for noise mitigation. The I-93 northbound and southbound lanes have different characteristics for AM and PM peak periods. The noise analysis used the PM peak period traffic conditions to evaluate the receptor locations nearest to the northbound lanes and the AM peak period traffic conditions to evaluate the receptor locations nearest to the southbound lanes.

Table 4.8-1
2020 Sound Levels (dBA)

Receptor Location[1] Number	Receptor Type	Receptor Location	2020[2] No-Build Alternative	2020 Build Alternative
Location 1	Residential	Hanson Avenue. – Salem	61 to 71	64 to 75
Location 2	Residential	Valeska Lane. – Salem	56 to 70	61 to 73
Location 3	Residential	Cross Street. – Salem	62 to 68	63 to 73
Location 4	Residential	McLarnon Road – Salem	59 to 66	60 to 68
	Commercial	Cross Street – Salem	64 to 68	65 to 69
Location 5	Residential	Woodland Terrace – Salem	58 to 67	58 to 71
	Commercial	S. Policy St / Raymond Ave – Salem	56 to 67	57 to 71
Location 6	Residential	Lowell Road - Salem	60 to 68	60 to 72
	Commercial	Keewaydin Drive – Salem	57 to 66	58 to 68
Location 7	Residential	Brookdale Road – Salem	60 to 70	60 to 73
Location 8	Residential	May Lane Drive – Salem	59 to 67	60 to 68
	Commercial	Manor / Industrial Parkway – Salem	54 to 68	55 to 69
Location 9	Residential	South Shore Road – Windham	66 to 70	67 to 72
Location 10	Residential	Squire Armour Road – Windham	48 to 65	49 to 66
Location 11A	Residential	Wildwood Road – Windham	58 to 68	59 to 70
Location 11B	Residential	Wildwood Road – Windham	58 to 68	52 to 58
Location 12A	Residential	Route 111A – Windham	58 to 66	58 to 68
Location 12B	Residential	Route 111A – Windham	58 to 66	58 to 68
Location 13A	Residential	West Shore Road – Windham	57 to 61	58 to 62
Location 13B	Residential	West Shore Road – Windham	57 to 61	53 to 58
Location 13 Center A	Residential	Between I-93 travel lanes – Windham	55 to 60	58 to 62
Location 13 Center B	Residential	Between I-93 travel lanes – Windham	55 to 60	62 to 64
Location 14 East	Residential	Gov. Dinsmore Road – Windham	54 to 64	55 to 65
Location 14	Residential	Country Road – Windham	58 to 68	59 to 70
Location 15	Residential	Morrison Road – Windham	58 to 66	58 to 67
Location 16	Residential	Spinnaker Drive – Derry	51 to 65	51 to 66
Location 17	Residential	Tracy Drive – Derry	52 to 66	54 to 68
Location 18	Residential	Fordway Extension - Derry	57 to 69	58 to 71
Location 19	Residential	Mathew Drive - Derry	55 to 66	58 to 68
	Commercial	Kendall Pond Road - Derry	60 to 66	62 to 68
Location 20	Residential	Charleston Avenue - Londonderry	52 to 66	55 to 69
Location 21	Residential	Reo Lane - Londonderry	58 to 66	60 to 68
	Commercial	Londonderry Road - Londonderry	58 to 66	60 to 70
Location 22	Residential	Ash Street - Londonderry	62 to 66	65 to 70
Location 23	Residential	Trolley Car Lane - Londonderry	59 to 66	60 to 68
Location 24	Residential	Seasons Lane - Londonderry	56 to 70	57 to 71
Location 25	Residential	Rockingham Road - Londonderry	49 to 66	52 to 69
Location 26	Residential	Perkins Road - Londonderry	49 to 62	51 to 63
Location 27	Residential	Newton's Meadow Way - Manchester	54 to 67	56 to 69
Location 28	Residential	Bodwell Road - Manchester	50 to 68	51 to 69
Location 29	Residential	Cohas Avenue - Manchester	50 to 67	51 to 68

Source: VHB, Inc.

1 See Receptor Locations and Sound Level Contours in **Figures 3.8-1 to 3.8-23**.

2 See Section 4.8.1 for discussion of why 2020 No Build Sound Levels are similar to 2000 Existing Sound Levels. The Noise Abatement Criteria are presented in Table 3.8-2.

■

4.8.3 2020 Build Alternative

The 2020 Build Alternative represents a worst-case condition for each receptor location, as discussed in Section 4.8.2. The 2020 Build Alternative sound levels are predicted to vary from 49 to 75 dBA, which represents up to a 5 dBA increase in sound levels as compared to the existing conditions. This increase is due to the combination of higher peak period traffic volumes, additional roadway capacity, and roadway alignment. Table 4.8.-1 presents the predicted sound levels for 2020 Build Alternative.

■

4.8.4 Secondary Impacts

The noise analysis calculated sound levels associated with traffic for the existing and design year (2020). These sound levels were based upon the traffic projections developed for the Selected Alternative and the various other alternatives, which are discussed in Section 4.2. Noise mitigation measures (i.e., noise barriers) were also developed based upon this information.

Secondary land use impacts associated with population growth potentially stimulated by the project are presented in Section 4.12 and used the same 2020 year for projections. However, noise impacts associated with this secondary growth cannot be reasonably estimated because the mix of commercial/industrial development as well as its exact location cannot be reasonably estimated. Similarly, noise associated with additional traffic is equally difficult to predict.

4.8.5 Mitigation

Noise mitigation measures were evaluated for receptor locations, where noise impacts have been identified. The primary mitigation measure considered for noise abatement for this project was a noise barrier. Noise barriers provide noise abatement by reducing the transmission of sound waves. This is accomplished by shielding receptor locations from the noise source by blocking the line of sight. Noise barriers are judged as effective when they achieve a 5 to 10 dBA or greater noise reduction for the critical receptor locations with noise impacts.

Noise mitigation measures were evaluated for receptor locations that were predicted to have adverse noise impacts. Adverse noise impacts are defined as receptor locations with 2020 Build Alternative sound levels that approach (within one decibel), are at or exceed the FHWA Noise Abatement Criteria (NAC) as described in Table 3.8-2, which is 67 and 72 dBA for residential and commercial areas respectively; or when the predicted sound levels exceed the existing sound levels by 15 dBA or greater. Table 4.8-2 presents the locations where noise mitigation measures are being proposed.

Table 4.8-2
Noise Mitigation Locations Based on 2020 Four-Lane Alternative

Receptor-Location Number	Receptor Location	Number of Receptors that Approach or Exceed the NAC	Number of Residences w/ a 5 dBA or Greater Reduction	Noise[1] Barrier Recommended
Location 1	Hanson Avenue. – Salem	77	90	Yes
Location 2	Valeska Lane. – Salem	6	7	No
Location 3	Cross Street. – Salem	6	6	No
Location 4	McLarnon Road – Salem	19	22	Yes
	Cross Street – Salem	0	NA	No
Location 5	Woodland Terrace – Salem	12	16	No
	South Policy Street – Salem	3	NA	No
Location 6	Lowell Road – Salem	20	26	Yes
	S. Policy St / Raymond Ave – Salem	0	NA	No
Location 7	Brookdale Road – Salem	10	15	Yes
Location 8	May Lane Drive – Salem	7	19	Yes
	Manor / Industrial Parkway – Salem	0	NA	No
Location 9	South Shore Road – Windham	14	14	Yes
Location 10	Squire Armour Road – Windham	1	3	No
Location 11A	Wildwood Road – Windham	8	18	Yes[3]
Location 11B	Wildwood Road – Windham	0	0	No
Location 12A	Route 111A – Windham	4	6	No[3]
Location 12B	Route 111A – Windham	4	6	No[2]
Location 13A	West Shore Road – Windham	0	0	No
Location 13B	West Shore Road – Windham	0	0	No
Location 13 Center A	Between I-93 travel lanes – Windham	0	0	No
Location 13 Center B	Between I-93 travel lanes – Windham	0	0	No
Location 14 East	Gov. Dinsmore Road – Windham	0	0	No
Location 14	Country Road – Windham	3	6	No
Location 15	Morrison Road – Windham	4	4	No
Location 16	Spinnaker Drive – Derry	4	16	No
Location 17	Tracy Drive – Derry	2	7	No
Location 18	Fordway Extension – Derry	2	4	No[2]
Location 19	Matthew Drive – Derry	14	26	Yes
	Kendall Pond Road – Derry	0	NA	No
Location 20	Charleston Avenue – Londonderry	12	25	No[2]
Location 21	Reo Lane – Londonderry	3	4	No
	Londonderry Road – Londonderry	0	NA	No
Location 22	Ash Street – Londonderry	2	3	No
Location 23	Trolley Car Lane – Londonderry	23	28	Yes
Location 24	Seasons Lane – Londonderry	10	19	Yes
Location 25	Rockingham Road – Londonderry	2	2	No[2]
Location 26	Perkins Road – Londonderry	0	0	No
Location 27	Newton's Meadow Way – Manchester	21	36	Yes
Location 28	Bodwell Road – Manchester	15	27	Yes
Location 29	Cohas Avenue – Manchester	11	14	No

Source: VHB, Inc.
1 Noise barrier evaluations are presented in Appendix F.
2 Privacy Fence Proposed.
3 Does not represent the Selected Alternative.

Noise abatement is not always possible or practical at all impacted receptor locations. In order for noise abatement measures to be considered, the following criteria must be met:

- The receptor locations must have predicted sound levels resulting in adverse noise impacts;
- The noise abatement measure must be able to provide a reasonable reduction (at least 5 dBA) in sound levels;
- The noise abatement measure must be cost effective;
- The noise abatement measure must be feasible to construct; and
- The noise abatement measure should not have substantial impact on other resources, such as wetlands, historic buildings, and endangered species.

The following noise abatement measures can reduce traffic noise impacts, but are not proposed as noted below:

- Traffic management measures, which could include specified vehicle restrictions and modified speed limits. These measures are not consistent with the project goals.
- Alteration of horizontal and vertical alignments. To the degree this is practical, this was a consideration. However within the constraints and goal for this project, substantial alterations of highway geometry solely to minimize noise is not feasible.
- Acquisition of property (such as a buffer zone). NHDOT Policy precludes purchasing homes and businesses solely on the basis of noise impacts.
- A detailed discussion of the noise barrier recommendations for all locations is provided in the Noise Barrier Data memo, which is presented in Appendix F. Sound Level Contours graphically display both the 60 and the 66 dBA levels as well as proposed noise barrier and privacy fence locations. The Sound Level Contours Figures are located in Volume 2 (**Figures 3.8-1 through 3.8-23**).

■

4.8.6 Construction Noise Impacts

Noise impacts from construction activities are closely related to the phase of construction and the type and placement of construction equipment at the site. Table 4.8-3 shows a variety of construction equipment that may be deployed at various stages of highway construction. Typical noise levels from this equipment are also shown.

Construction activities would result in a substantial but temporary noise impact to receptors at various locations adjacent to proposed construction. Noise levels would vary depending on the type and number of pieces of equipment active at any one

time. It is expected that noise levels exceeding 67 decibels could occur up to 500 feet away from construction activities. In general, construction noise would be restricted to daylight hours, although night construction will be required given the need to maintain traffic in both directions much of the time during daylight hours.

In an effort to minimize construction noise, proposed noise barriers will be built as soon as possible so that they may provide a reduction in subsequent construction noise to the residences. However, at some locations (such as Location 6, Lowell Road in Salem) the noise barrier will need to be the last phase of construction due to the location of temporary detour roadway.

Bridge construction represents a source of higher noise levels due to pile driving and other activities. Major bridge construction is planned for the following locations:

- Cross Street (over I-93 NB & SB)
- I-93 Exit 1 SB On & Off Ramps (over I-93 NB & SB)
- I-93 Exit 1 SB On Ramp (over South Policy Street)
- I-93 NB & SB (over Lowell Road, NH 38)
- I-93 NB & SB (over Porcupine Brook)
- I-93 NB & SB (over Pelham Road, NH 97)
- I-93 Exit 2 SB On Loop Ramp (over Pelham Road, NH 97)
- Brookdale Road (over I-93 NB & SB)
- I-93 NB & SB (over NH 111A)
- I-93 NB & SB (over NH 111)
- I-93 Exit 3 NB & SB Loop Ramp (over NH 111)
- I-93 NB & SB (over North Lowell Road)
- I-93 NB & SB (over Fordway Extension)
- I-93 NB & SB (over Kendall Pond Road)
- I-93 NB & SB (over Beaver Brook)
- NH 102 (over I-93 NB & SB)
- Ash Street (over I-93 NB & SB)
- I-93 NB & SB (over Stonehenge Road)
- I-93 NB & SB (over NH 28)
- I-93 NB & SB (over Railroad Corridor)
- I-93 NB (over Cohas Brook Sta. 1917+00)
- I-93 NB (over Cohas Brook Sta. 1965+00)
- I-93 NB & SB (over Bodwell Road)
- I-93 / I-293 NB (over Cohas Brook Sta. 1989+00)

Ledge removal also represents a source of higher noise levels due to blasting and other activities. Major ledge removal is anticipated for the following locations:

- I-93 NB & SB (500-foot section south of Exit 3 Interchange)
- I-93 NB & SB (2,500-foot section within Exit 3 Interchange)
- I-93 NB & SB (1,000-foot section north of Exit 3 Interchange)
- I-93 NB & SB (1,500-foot section south of North Lowell Road)
- I-93 NB & SB (1,500-foot section north of North Lowell Road)
- I-93 NB & SB (2,500-foot section north of Windham/Derry Townline)
- I-93 NB & SB (1,000-foot section within Exit 4 Interchange)
- I-93 NB & SB (1,600-foot section north of Pillsbury Road/Ash Street)

- I-93 NB & SB (3,500-foot section north of Stonehenge Road)
- I-93 NB & SB (1,500-foot section at the Londonderry/Manchester Townline)
- I-93 NB & SB (1,500-foot section south of Bodwell Road)

Table 4.8-3
Construction Equipment Noise Emissions

Equipment Type	Noise Levels (dBA @50FT)
Earthmoving	
Front Loader	84
Backhoe	84
Bulldozer	88
Tractor	84
Scraper	90
Grader	83
Truck	90
Paver	84
Vibrator	76
Materials Handling	
Concrete Mixer	83
Crane	82
Derrick	88
Stationary	
Pump	71
Generator	81
Compressor	89
Impact Devices	
Pile Driver	91
Pavement Breaker	89
Pneumatic Tool	80

Source: "Highway Construction Noise: Environmental Assessment and Abatement, Volume IV: User's Manual". Vanderbilt University, Nashville, TN. Report No. VTR-81-3, 1981.

■

4.8.7 Summary

The receptor locations that are approximately located within 500 feet of the existing I-93 travel way currently experience sound levels that approach, are at, or exceed the FHWA's Noise Abatement Criteria (NAC). The I-93 Build Alternatives will result in capacity and alignment improvements that will result in relatively slight, up to 5 dBA, increases in sound levels to these receptor locations.

The noise analysis evaluated 35 receptor locations that included over 1,200 residential and commercial buildings. Future 2020 Build Alternative sound levels are

expected to exceed the NAC along the I-93 corridor. Receptor locations 11B, 13A, 13B, 13 Center A, 13 Center B, 14 East, and 26 (as depicted in **Figures 3.8-1 to 3.8-23)** are expected to experience sound levels below the threshold level of the NAC. Noise mitigation measures were evaluated for all the receptor locations that were found to approach, be at, or exceed the NAC under the 2020 Build Alternative to determine if noise levels could be reduced. Noise barriers were evaluated as the primary mitigation measure. The FHWA's and the NHDOT's noise abatement criteria and guidelines were used to evaluate each receptor location. Mitigation measures were found to be reasonable and feasible for 12 receptor locations (Receptor locations 1, 4, 6, 7, 8, 9, 11A, 19, 23, 24, 27, and 28) based upon acoustical, engineering, and economic considerations. However, since location 11A is not associated with the Selected Alternative, 11 receptor locations are proposed to be mitigated. Noise barriers for the remaining 16 receptor locations were found to not meet the cost-effective criteria because there were not enough impacted residences that could achieve an adequate noise reduction. In addition, 4 receptor locations (Receptor locations 12B, 18, 20, and 25), which had sound levels that exceeded the NAC, but did not meet the noise barrier criteria, were determined eligible to receive a privacy fence. A detailed discussion of the noise barrier evaluation is presented in Appendix F.

■

4.8.8 Future Noise Levels for Planning Purposes

The noise analysis has developed data that may be useful to local officials in their planning efforts for future development along the existing I-93 corridor. In order to limit the creation of new noise impacts based upon the FHWA Noise Abatement Criteria (i.e., less than 66 dBA for residential development and 71 dBA for commercial development) in the year 2020, the following is suggested for the local officials' consideration:

- Along existing I-93 corridor, residential development would ideally be no closer than the 66 dBA noise contour as presented in **Figures 3.8-1 to 3.8-23**.
- New development should include a buffer area for potential future noise abatement.

4.9 Visual Impacts

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4.9.1 Build Alternatives

Probable visual effects on the resources outlined in Chapter 3 were considered and are reported by alternative below.

In general, widening the highway would increase the overall roadway footprint and create larger cut and fill slopes, which will increase the visual scale of the roadway. The larger footprint will also necessitate removal of some existing roadside vegetation. Where this vegetation is part of forested buffer between the highway and adjacent development, this would have an adverse effect upon the quality of views from the highway.

Removal or reduction of the vegetative buffers between the highway and development would have a more substantial adverse effect on nearby residences and businesses than on highway users. In addition, removal of forested areas and/or ledge within the median will change the visual environment for highway users from a rural/forested setting to a more built environment by eliminating portions of the visual buffer between the northbound and southbound barrels.

The discussion below highlights potential impacts to the visually sensitive resources for each highway segment identified in Section 3.9, including areas where vegetative buffers provide screening of the highway from residential areas adjacent to the project.

Three-Lane Alternatives

Segment A

The widened highway will encroach on the Haigh Avenue residential area in Salem on the easterly side of I-93 south of the Rest Area, resulting in the removal of existing forested buffer. In this location, a sound wall will be erected which will screen the residential area from the highway. A small vegetated buffer will remain between the residences and the sound wall.

Segment B

No adverse impacts will result to the Brady Avenue scenic corridor, since the visually sensitive portion of the corridor is not located in the immediate vicinity of I-93.

Two residential areas located to the east of Exit 1 may be affected by the reconstruction of the northbound off-ramp, which may remove a portion of the existing vegetative buffer between the highway and several homes on McGregor Road and McLarnon Road. In this area, construction of a sound wall is planned that will shield the residences from the highway. Both the Three-Lane and Four-Lane Alternatives have similar impacts in this location.

Segment C

The highway upgrade will remove forested buffer between the highway and adjacent residences on Trolley Lane north of NH 38 in Salem. Construction of the Three-Lane Alternative is expected to remove enough vegetative buffer such that the

highway will become visible to approximately four homes in this area, which would have a moderate adverse effect on these properties.

The mobile home park on Fern Road south of NH 38 on the west side of I-93 would also lose a portion of the vegetative screening. A sound wall will be constructed which would shield residences from the highway. Additionally, reconstruction of the highway in the Exit 2 area will result in the removal of portions of the existing forested buffer and ledge outcrops between the northbound and southbound barrels. Under the Three-Lane Alternative in the vicinity of Exit 2, highway users will have views of the opposite barrel where the forest and ledge in the median now provide a buffer and creates a relatively rural, forested visual setting. The highway widening will change the visual environment in this vicinity to a more open, built environment with views of the opposite highway barrels. Both the Loop and Diamond Interchange Options for Exit 2 will have this effect.

Segment D

The widening in Segment D involves either shifting approximately 0.8 miles of the northbound barrel of the highway into the existing highway median in the immediate vicinity of Exit 3 (i.e., the Northbound Shift) or shifting both barrels of the highway along approximately 1.9 miles of highway (i.e., the Tight-Shift Option). Additionally, the Preferred Alternative or Tight Shift Option would reduce the steep grade of the southbound barrel near Exit 3 to improve traffic operations and safety.

Both the Northbound-Shift Option and the Tight-Shift Option will reduce the overall footprint of the Exit 3 Interchange, but will result in the removal of substantial areas of forest and ledge. The Tight-Shift Option in particular will result in substantial forest clearing and ledge cuts for approximately 1.5 miles south of Exit 3.

Despite the relatively substantial change to the visual environment in this Segment, only a few viewers of the highway are likely to be directly impacted. Specifically, two residential areas to the west of the current I-93 alignment in Segment D consisting of fewer than 12 homes are likely to see the change in the visual character of the area. These neighborhoods are located on NH 111A/Lower Locust Road and Squire Armor Road in Windham. Conversely, moving the roadway away from West Shore Drive will be a benefit to the adjoining neighborhood. These properties are located within 100 to 500 feet of I-93 at an elevation that allows views of the highway. The homes are partially shielded from the highway by a vegetative buffer that will remain largely intact. But the change in the visual scale of the highway represents a moderate adverse impact for the Northbound Shift Alternative, and a moderate to high adverse impact for the Tight-Shift Alternative. Additionally, the Build Alternatives all propose to increase the height of the bridge carrying I-93 over NH 111A. In the case of a few residences on NH 111A, the higher bridge structure will further increase the visual scale of the adjacent highway.

The changes at Exit 3 will also change the visual character of the highway for motorists. The larger, straighter highway will create a more homogeneous visual setting than is now present.

Options in Segment D also include a relocation of approximately 0.9 miles of NH 111. The relocated NH 111 will cross an intact forested area of relatively high visual character north of existing NH 111. Portions of the relocated section will be visible to motorists on I-93, adjacent to commercial properties, and to some degree residences fronting along existing NH 111 in the area. Approximately one-third of the relocated NH 111 will be located in a cut and will be fully or somewhat visually shielded from the residences adjacent to Cobbetts Pond to the south (e.g., on Rocky Ridge Road).

No change will occur to the visual setting of Searles Castle, a locally important cultural feature located on a hillside approximately 2000 feet to the northeast of Exit 3. The Castle property does not currently have a view of the highway, and even with the change in the vicinity of Exit 3 a substantial vegetative buffer will continue to shield the Castle.

Segment E

The project will have no impact on the open space and recreational areas identified in the Derry Master Plan (Table 3.9-1), since these areas are not located adjacent to the highway and have no views to or from the highway.

Four neighborhoods in Segment E are located in close proximity to the existing highway and may be affected by removal of the existing vegetative buffer between residences and the highway corridor. Construction of the Three-Lane Alternative will have a low adverse impact on Fordway Extension and Derryfield Road in Derry and Charleston Avenue (impacted by the westerly widening option only) and Trolley Car Lane in Londonderry. A privacy fence or a sound wall is planned for each of these areas, which should mitigate adverse visual impacts for the homeowners to some degree.

Moderate adverse impacts are expected to users of the Woodmont Orchard in Londonderry since all alternatives will impact the existing wooded buffer between the orchard and the highway. The Westerly Option in Segment E would remove almost the entire 100-foot buffer, while an Easterly Widening would allow some wooded buffer to remain between the roadway and the orchard. The Easterly Widening would minimize the effect of the project upon users of the orchard, which is considered open space in the community.

Segment F

The majority of the highway corridor in Segment F is forested, which provides screening of the adjacent highway barrel and creates a rural/undeveloped visual setting. The portion of the highway from Stonehenge Road to Exit 5 (NH 28) will be affected by removal of the forested buffer currently present in the median. No adverse effect will result north of Exit 5 since only a slight amount of vegetation

clearing in the median or along the sides of the corridor will result from the Build Alternatives.

There are no residential areas within Segment F where the highway project will affect visual buffers.

Four-Lane Alternative

Impacts associated with the Four-Lane Alternative are essentially identical to the Three-Lane Alternative. The Four-Lane Alternative adds an additional 12 feet of highway width for both the north and southbound barrels, resulting in a slight increase of the visual scale of the Four-Lane widening of the highway relative to the Three-Lane Alternative. The Four-Lane Alternative would result in a moderate adverse effect on the residences and businesses in close proximity to the reconstructed or relocated highway at the locations discussed in the Three-Lane Alternative above.

Four-Lane/Three-Lane Combination Alternative

This alternative would result in the same visual impacts as the Four–Lane Alternative through Exit 3. North of Exit 3, the visual impacts are the same as the Three-Lane visual impacts. The additional lane south of Exit 3 would necessitate a small amount of additional clearing in forested areas along the highway to accommodate the extra width. This clearing will remove some additional screening between the highway and any adjacent residential or commercial areas.

Park-and-Ride Facilities

The proposed park-and-ride lots at Exits 2, 3 and 5 will vary in size from 8 to 12 acres each. In most cases, additional removal of natural vegetation will be necessary and will result in some reduction in the visual screening between the lots and any nearby residences (*e.g.*, along South Policy Road at the proposed Exit 2 facility, along West Shore Drive at Exit 3).

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4.9.2 No-Build Alternative

The No-Build Alternative would not directly alter the visual environment.

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4.9.3 Secondary Impacts

Impacts associated with secondary growth are discussed in Section 4.12 of this document. As discussed, the impact analysis suggests that the project could result in an additional population increase of 40,626 people and an increase of 21,527 new jobs by the year 2020 as compared to the No-Build Alternative. By extrapolation, it was further estimated that 19,356 additional acres of undeveloped land may be converted

to accommodate residential development and 479-867 acres may be converted to accommodate the business growth that would create these new jobs. Using an average of 673 acres associated with business growth, the total number of additional acres that may be converted with the Build Alternative is approximately 20,100.

Over the last several decades, New Hampshire has experienced a shift from a rural and forested visual character to a more suburban character as housing and commercial development has converted previously undeveloped land. Continued growth is expected whether I-93 is widened or not. Secondary growth is expected to have a minor incremental effect on this increased suburbanization of southern New Hampshire.

■

4.9.4 Mitigation

Mitigative treatments will be developed at the final design stage. These measures will include:

- Landscape planting and natural revegetation of the cut and fill slopes, and as appropriate, at the park-and-ride facilities.
- Structural design considerations for drainage structures, bridges, etc. to enhance their visual appearance.
- Highway lighting at interchanges and park-and-ride facilities, will be designed with "cut offs" or similar features to limit unwanted light where appropriate.
- Since areas that are visually impacted are also often impacted by noise, sound walls will serve a dual purpose by mitigating for both noise and visual impacts. In general, landscaping amenities will be constructed in conjunction with the sound walls, where practicable.
- Privacy fencing in four locations (at NH 111A in Windham, Fordway Extension in Derry, Charleston Avenue in Londonderry and Rockingham Road in Londonderry) will also help shield adjacent residential properties from the visual impacts of the highway.
- Additional privacy fence locations or landscape screening to minimize the visual impact of the highway and mitigate for the loss of existing vegetative screening will be considered and evaluated as part of the discussions with affected property owners during final design.

4.10 Cultural Resources Impacts

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4.10.1 Archaeological Resources

4.10.1.1 Impact Method

The National Environmental Policy Act requires that federal agencies assess the effects of a proposed project on archaeological resources that are identified in the Phase II level of investigation as eligible for the National Register of Historic Places. It further directs the agency to consider how project alternatives reduce the impact of those effects on archaeological properties by in-place preservation where possible (See Section 3.10.4.3 for a description of archaeological phases.) Following the completion of the DEIS, archaeological sites in the project corridor were re-examined to determined the level of integrity of the identified sites and to complete most of the investigations through the Phase IB level. (See Table 3.10-1 and 3.10-2.) This site re-examination considerably reduced the number of impacted, potentially eligible archaeological sites.

The potential effects of each alternative on identified archaeological resources and archaeologically sensitive areas were determined by overlaying each alternative on the original archaeological resources constraints map. The map scale used for this analysis was 1:800. Resources identified on **Figure 3.10-1** were examined at the Phase IB level and are the sites found potentially eligible for the National Register. Because the extent of most of the sites has yet to be identified, impact is defined judgmentally as present or absent. Impacts were analyzed for all segments.

Because the Three- and Four-Lane Alternatives as well as the Four-Lane/Three-Lane Combination Alternative have similar impacts on archaeological sites at the current level of information, the effects are analyzed at the Four-Lane level only. Typically, site boundaries are not identified until Phase II investigations, which have not yet been completed. Impacts to archaeological sites are summarized in **Figure 4.10-1** and are described in the next section.

4.10.1.2 Build Alternatives

Testing between the DEIS and the FEIS has examined all the archaeologically sensitive areas noted in the DEIS, resulting in the elimination of many of these areas because they failed to yield important archaeological data. Consequently, the total number of potentially impacted archaeological sites is now reduced to 23 sites.

Segment A

Only one option for Segment A, the linear area between the Massachusetts border and Cross Street, is proposed. Archaeological investigations did not identify archaeological sites within Segment A.

Segment B

Segment B that includes Exit 1 was analyzed for both Option 1 reconstruction and Option 2 relocation. Neither Option 1 nor Option 2 will impact identified archaeological sites.

Segment C

Segment C that includes Exit 2 was analyzed for both the loop and diamond options. Two of the identified archaeological sites, sites 27 Rk 328 and 27 Rk 364, are impacted by both options. Site 27 Rk 328 will require additional Phase IB testing. If the Phase IB investigation indicates more extensive deposits than identified to date, a Phase II evaluation will follow. Further investigation at 27 RK 364 will entail additional research. Depending on the results of the research, further Phase II archaeological investigations may be necessary

Segment D

Segment D that includes Exit 3 was analyzed for all options. All nine options impact between eight and nine archaeological sites. Eight sites including sites 27 RK 7, 27 Rk 331, 27 Rk 333, 27 Rk 336, 27 Rk 366, 27 Rk 367, 27 Rk 368, 27 Rk 369, and H438/40/47-28 are impacted by all of the options. Site 27 Rk 365 is impacted by Options 3, 4, 5, 6, 8, and 9. Phase II evaluation is recommended for 27 Rk 7, 27 Rk 333, 27 Rk 367, 27 Rk 368, and 27 Rk 369. And, further Phase IB testing and Phase II testing if additional deposits are identified are recommended for sites 27 Rk 331 and 27 Rk 336. Found during the archaeological survey, site 27 Rk 366, a stone wall likely associated with Searles Castle, will undergo documentation by an architectural historian. Finally, 4-38/40/47-28, Old County Road, may constitute part of an archaeological district with the remains of adjacent farmstead along it represented by sites 27 Rk 7, 27 Rk 367, 27 Rk 368, and 27 Rk 369. Further examination of sections of this corridor will be necessary.

Segment E

Segment E that includes Exit 4 was analyzed for both Options 1 and 2 the east and west shifts. Option 1 impacts two sites, 27 Rk 370 and 27 Rk371. Phase II investigations will be necessary for both sites. Option 2 has does not impact archaeological resources.

Segment F

Segment F that includes Exit 5 was analyzed for all options Options 1 2 and 3. These options incorporate the relocation of NH Route 28, the reconstruction of NH Route 28, and the relocation of the northbound ramps. All three options impact nine sites: 27 Hb 15, 27 Hb 17, 27 Hb 19, 27 Hb 20, 27 Hb 216, 27 Hb 218 27 Hb 219 27 Hb 220, and 27 Rk 372. Phase II investigations are recommended for 27 Hb 15, 27 Hb 17, 27 Hb 19, 27 Hb 20, 27 Hb 216, 27 Hb 219, and 27 Hb 220. If supplemental testing at the Phase IB level indicates additional deposits, a Phase II evaluation of site 27 Hb 218 would follow. Phase II investigations of site 27 Rk 372 would depend on the results of additional detailed research for the site, specifically the potential for the site to be a blacksmith shop.

Sound Walls

Because the sound walls are located in the proposed right-of-way, impacts to archaeological sites are shown as part of the Build Alternative discussion (see Table 4-10-1). For additional discussion about sound walls, see Section 4.8.4 and Table 4.8-2.

Park-and-Ride Lots

The proposed park-and-ride lot at Exit 2, which impacts 27 Rk 364, the Boyer Lane Quarry require further investigation, including research to identify the operator of the quarry site and period of operation. No further test pit excavation is currently recommended, but this may change depending on the results of the research. Phase IB investigations will occur at undisturbed locations at the Exit 5 Park-and-Ride (Table 3.10-3).

Mitigation Sites

Further investigations are required at some of the 17 mitigation sites. Sites # 30, 32, 46, and 53 will not receive further investigation because of their high level of disturbance or their absence of archaeological sensitivity. Undisturbed areas selected for wetland creation will undergo all phases of necessary archaeological investigation. These locations include wetland mitigation sites 24 and 38. Those areas selected for wetland preservation, including sites 24, 38, 44, 45, 47, 49, 58, 61, and 63, will undergo surface inspection to document visible surface remains on minimal NHDHR Archaeological Inventory Forms. Wetland mitigation sites 3, 14, 15, 16, and 31 have already undergone a surface inspection. Wetland preservation sites are to remain undisturbed. However, if future projects, which will disturb the ground's surface, are identified in these preservation areas, all necessary phased archaeological investigations will be completed in undisturbed archaeologically sensitive locations as summarized in Table 3.10-3.

4.10.1.3 No Build

The No-Build Alternative will not affect identified archaeological sites or sensitivity areas since new construction would not occur.

4.10.1.4 Further Investigations and Potential Mitigation

Figure 4.10-1 illustrates in a matrix format the number of identified archaeological sites impacted by each option. Because boundaries of each site are not defined, the acreage impacted by each option cannot be computed at this stage. This matrix also indicates the number of options that impact each site.

Mitigation

Recommendations for the next phase of site investigation are provided in Tables 3.10-1 and 3.10-3. The NHDHR and FHWA have reviewed these recommendations for future studies. During the final design phase, archaeological investigations at the Phase II level will determine the eligibility of these sites for the National Register of Historic Places. These investigations would also provide clear site boundaries Supplemental Phase IB investigations will be necessary for five of the sites. If these sites retain sufficient archaeological material and integrity, then Phase II investigations will proceed.

The determination of effects (DOE) and the Section 4(f) analysis of these archaeological sites cannot be completed prior to the completion of the FEIS because site significance has not been determined and site boundaries have not been identified. Because of the time-consuming nature of archaeological investigations, Phase II is not usually completed until the final design stage when the Selected Alternative is confirmed and the FEIS is completed. Because site significance has not been determined and site extent is not yet verified, a 4(f) analysis cannot be completed. Determination of site boundaries provides the area of each site within the corridor , enabling the completion of the Section 4(f) analysis. However, it is unlikely that archaeological sites will be determined to be eligible for this protection under Section 4(f).

Once the additional studies are completed to the Phase II level for those sites along the selected alignment, as shown in Tables 3.10-1 and 3.10-3, the level of effect to those sites found to be eligible for the National Register can be determined. Some sites may require mitigation, depending on the area of impact by the project. At least three approaches to the mitigation of these archaeological resources are possible.

A decision of the importance of preservation-in-place versus data recovery will need to be made. If preservation in-place is found to be necessary, then a change in design or location will be made, where feasible and prudent, to satisfy Section 4(f). In some cases, the location of the corridor may be moved slightly or work adjacent to the site

may be modified so that the site will not be impacted by the Selected Alternative. Preservation-in-place preserves the site for future archaeological study when it may address new research needs that may not be currently identified. If preservation-in-place is not required and data recovery becomes the appropriate form of mitigation, then Section 4(f) does not apply to the resource. The second form of mitigation then involves the recovery of the information that the site may yield under National Register Criterion D by implementing a data recovery plan. Thirdly, in a few cases, previously identified archaeological sites in the vicinity of, but not impacted by, the alignment and of a similar age, type, function, and composition may provide similar or superior data to address research questions identified for the significant site impacted by the Selected Alternative. In this instance, the mitigation would consist of this previously identified site being excavated using a data recovery program. While this form of mitigation needs to be completed prior to the completion of the project, its excavation can continue while work commences within the corridor. Whether archaeological information is gained through the excavation of the site within the corridor or an alternative site, information would be distributed to the public through such venues as site reports, public lectures, school programs, interpretive brochures, and, depending on the nature of the site, public visitation during investigations.

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4.10.2 Historic Resources

4.10.2.1 Methods To Determine and Evaluate Impacts

At a meeting of NHDHR, FHWA, NHDOT and the consultant team held on March 14, 2002, impact evaluations were made for historic properties that had been determined eligible for the National Register of Historic Places. Consensus determinations were made in all cases. NHDHR/FHWA Determinations of Eligibility/Effect (36 CFR 800) forms are included in Appendix G. An Effect Memo was signed August 8, 2002.

Criteria of Effect and Adverse Effect were determined based on the Section 106 review process established by the National Historic Preservation Act of 1966 and outlined in 36 CFR 800.9, which defines the following:

No Effect: The undertaking will not affect any historic property.

Effect: The undertaking may alter National Register-qualifying characteristics and features of location, setting or use.

Adverse Effect: The undertaking may diminish the integrity of design, setting, materials, workmanship, feeling or association. Adverse effects include, but are not limited to:

- Physical destruction, damage, or alteration of all/part of the property,
- Isolation from or alteration of the character of the property's setting when that character contributes to the property's qualification for the National Register,
- Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting,
- Neglect of a property resulting in its deterioration or destruction, or
- Transfer, lease, or sale of the property.

Otherwise adverse effects may be considered not adverse in the following circumstances:

- When the property is of value only for potential contribution to research, and when such value can be substantially preserved through appropriate research in accordance with professional standards and guidelines,
- When the undertaking is limited to rehabilitation of buildings and structures and is conducted in a manner that preserves the historical and architectural value of affected historic property through conforming with the Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings, or
- When the undertaking is limited to transfer, lease, or sale of a historic property, and adequate restrictions or conditions are included to ensure preservation of the property's significant historic features.

No Adverse Effect: The undertaking may affect one or more historic properties, but the effect will not be harmful to the National Register qualifying aspects of the property.

4.10.2.2 Build Alternatives

A description of the impacts on individual historic properties is given below. A summary of the impacts on historic resources is provided in a matrix format in **Figures 4.10-2 and 4.10-3** for the Three-Lane and Four-Lane Alternatives, respectively.

Three-Lane Alternative

Segment A

There are no Section 106 impacts in Segment A. The Three-Lane and Four-Lane Alternatives are exactly the same in this segment and create a 4(f) impact on the

Kinzler House (SAL0204), located on Cross Street. Some 2,200 square feet will be acquired for right-of-way and 1,200 square feet for slope work. However, there is no Section 106 impact to the property because the property-take does not impact the significant features of the eligible resource.

Segment B

There are no impacts in Segment B.

Segment C

There are no impacts in Segment C.

Segment D

Options 1, 2 and 7 in Segment D create a 4(f) impact on the George Dinsmore House (WND0033) through slope work that would affect 1,500 square feet of the 1.1-acre eligible parcel.[44] However, the undertaking would not alter any of the National Register-eligible characteristics of the property, thus no Section 106 adverse effect will occur.

Options 7 through 9 in Segment D will involve an adverse effect under Section 106 and a 4(f) impact to two historic properties: the Robert Armstrong House (WND0086) and the George Armstrong House (WND0085), both located on NH 111A (Range Road) in Windham. Both properties will need to be acquired and the historic building will need to be relocated or demolished.

Segment E

Three impacts to historic properties will occur in Segment E. The widening of the northbound and southbound lanes of I-93 will necessitate the replacement of the Robert J. Prowse Bridge (LON0116), which is eligible for the National Register. This constitutes an adverse effect through physical destruction of the historic structure under Section 106. This would also involve a Section 4(f) impact.

The Woodmont Orchards Historic District (LON-D1) will be impacted under the Westerly Option by right-of-way acquisition of slightly less than 5.4 acres along the west side of I-93 in Segment E and slope impacts to a little less than 3.6 acres in the same area. These impacts will alter integrity of location, setting, and use and may diminish integrity of design, setting, materials, workmanship, feeling, and association within the district, resulting in both a Section 106 adverse effect and a 4(f) impact. There are no impacts to this property with the Easterly Option.

44 Since the actual extent of slope work on this property will only be known after final design, right-of-way take or a permanent easement was assumed as the worst-case scenario for the prediction of impacts.

The 114.4-acre Reed Paige Clark Homestead (LON0114) on Stonehenge Road will be impacted by the loss of approximately 2 acres of land along its eastern boundary with I-93 due to right-of-way acquisition, of which 0.2 acres of land will be affected by slope work. The impacts would not create an adverse effect under Section 106, because the work will not affect any National Register eligible characteristics of the property. This area has been previously disturbed by construction and was not traditionally part of the agricultural operations because of its topography. However, acquisition of 2 acres from the site constitutes a Section 4(f) impact.

Segment F

The Gearty House (LON0105) on Stonehenge Road will be affected by right-of-way acquisition of 100 square feet and slope work on 365 square feet of the property along its frontage. The work would result in a Section 4(f) impact and constitutes a Section 106 adverse effect.

Four-Lane Alternative

Segment A

There are no Section 106 impacts in Segment A. The Three-Lane and Four-Lane Alternatives are exactly the same in this segment and create a Section 4(f) impact on the Kinzler House (SAL0204), located on Cross Street. Some 2,200 square feet will be acquired for right-of-way and 1200 feet for slope work. However, there is no Section 106 impact to the property because the property-take does not impact the significant features of the eligible resource.

Segment B

There are no impacts to historic properties in this segment.

Segment C

There are no impacts to historic properties in this segment.

Segment D

Options 1, 2 and 7 in Segment D would create a Section 4(f) impact on the George Dinsmore House (WND0033) through slope work that would affect 1,500 square feet of the 1.1-acre eligible parcel. However, there is no Section 106 impact to the property because the property-take does not impact the significant features of the eligible resource.

Options 7 through 9 in Segment D will involve an adverse Section 106 effect and a Section 4(f) impact to two historic properties: the Robert Armstrong House (WND0086) and the George Armstrong House (WND0085), both located on NH 111A (Range Road) in Windham. Both properties will need to be acquired and the historic structures on these properties will need to be relocated or demolished.

Segment E

Three impacts to historic properties will occur in Segment E. The widening of the northbound and southbound lanes of I-93 will necessitate the replacement of the Robert J. Prowse Bridge (LON0116), which is eligible for the National Register. This constitutes an adverse effect through physical destruction of the historic structure under Section 106 and would also involve a Section 4(f) impact.

The Woodmont Orchards Historic District (LON-D1) will be impacted by right-of-way acquisition of 5.4 acres along the west side of I-93 in Segment E and slope impacts to 3.6 acres in the same area for the Westerly Option. These impacts will alter integrity of location, setting, and use and may diminish integrity of design, setting, materials, workmanship, feeling, and association within the district, resulting in both a Section 106 adverse effect and a Section 4(f) impact. There are no impacts to this property with the Easterly Option.

The 114.4-acre Reed Paige Clark Homestead (LON0114) on Stonehenge Road will be impacted by the loss of approximately 2 acres of land along its boundary with I-93 due to right-of-way acquisition, of which 0.4 acres of land will be affected by slope work. The impacts would not create an adverse effect under Section 106, because the work will not affect any National-Register eligible characteristics of the property. This area has been previously disturbed by construction and was not traditionally part of the agricultural operations because of its topography. However, acquisition of 2 acres from the site constitutes a Section 4(f) impact.

Segment F

The Gearty House (LON0105), which contains 1.5-acres, will be affected by right-of-way acquisition of 100 square feet and slope work on 365 square feet of the property along its frontage. This will result in a Section 4(f) impact, and constitutes an adverse Section 106 effect.

Four-Lane/Three-Lane Combination

Under the Combination Alternative in Segments A through C, only one historic resource (Kinzler House, SAL0204) will have a Section 4(f) impact, but there will be no adverse effect under Section 106 since the National Register-eligible characteristics will not be altered. Impacts in Segments D through F are the same as described above for the Four-Lane Alternative.

Sound Wall

Since the sound walls are being erected within the highway right-of-way (either existing or proposed), the impacts on eligible historic properties have already been taken into account in the above descriptions for the Build Alternatives.

Park-and-Ride and Wetland Mitigation Sites

There are no impacts to architectural properties.

4.10.2.3 No-Build Alternative

The No-Build Alternative has no direct effect on historic resources.

4.10.2.4 Mitigation

If a project cannot be designed to avoid historic properties, then appropriate mitigation to reduce impacts will be provided. This mitigation can include documenting the adversely affected properties using HABS (Historic American Buildings Survey) or HAER (Historic American Engineering Record) standards; minimizing land acquisition and maximizing the distance between the highway corridor and the historic structure; providing access as necessary to maintain existing land uses; and providing landscaping and screening where appropriate to minimize visual and noise impacts.

The following properties are being mitigated because of Section 106 and 4(f) impacts. Mitigation measures for this project are listed below on a property-by-property basis, with applicable alternatives identified. See also the Memorandum of Agreement in Volume 3, Appendix G, signed by NHSHPO, FHWA, and NHDOT for specific mitigation measures related to the Selected Alternative. (Properties which do not have Section 106 adverse effects may have Section 4(f) impacts. See Chapter 5 for a discussion of Section 4(f) impacts.)

The George F. Armstrong House (WND0085)

The mitigation for the loss of this property under Options 7 through 9 of the Three- and Four-Lane Alternatives is to record the buildings to HABS standards. It will then be marketed with a protective covenant for relocation to an appropriate setting. A portion of demolition costs may be allocated as an incentive for relocation.

Robert Armstrong House (WND0086)

The mitigation for the loss of this property under Options 7 through 9 of the Three- and Four-Lane Alternatives is, in part, to record the house to HABS (Historic American Building Survey) standards following NHDHR guidelines. Because of the very high architectural quality and integrity of the house, the building will be purchased by NHDOT and, if feasible, will be relocated to a nearby location with a suitable setting. The NHDOT will conduct a building relocation study for the move. If appropriate, the NHDOT will provide a stone or stone-faced foundation compatible with the existing, and provide water and sewer to the building. NHDOT

will transfer the property to a new owner with protective preservation/maintenance covenants, which will run with the dwelling.

Woodmont Orchards Historic District (LON-D1)

There is no effective mitigation for the adverse effect of slope work under the Three-Lane and Four-Lane Westerly Options. The Three-Lane and Four-Lane Easterly Options would avoid this impact.

Robert J. Prowse Memorial Bridge (LON0116)

The mitigation for the loss of this structure is, in part, to document the bridge to HAER (Historic American Engineering Record) standards following state guidelines. In addition:

- If feasible, NHDOT will replace the bridge with a rigid frame structure of compatible design.

- NHDOT will make a concerted effort to find an adaptive reuse for the bridge prior to construction of the associated segment of the project. The feasibility of reuse will be determined through cost benefit analysis and structural analysis. If feasible, NHDOT will move the bridge to a new location.

- If the NHDOT, or other state agencies, do not identify a use for the bridge, the NHDOT will advertise the bridge for reuse by others in New Hampshire. The NHDOT will initiate steps to market the bridge in accordance with Section 144(a) of Title 23, U.S.C., which was created by Public Law 100-17 (Surface Transportation and Uniform Relocation Assistance Act of 1987).

- The availability of the bridge will be advertised in local and regional newspapers and national preservation publications on a regular basis for a period of time agreed to by FHWA, NHDOT, and NHSHPO. The bridge will be made available to a state, local, or responsible private entity, if such entity enters into an agreement to: a) preserve and maintain the bridge and those features that make it historically significant; and, b) assume all future legal and financial responsibility for the bridge. Federal-aid highway funds will be made available for its relocation up to the estimated cost of demolition. The bridge's plaque will remain with it unless an adaptive use cannot be found in which case it will either be placed in the exhibit described below or exhibited in the NHDOT lobby.

- NHDOT will place an interpretive exhibit about its design and fabrication at the Salem Rest Area. NHSHPO will review and approve the exhibit's content.

Gearty House (LON0105)

The mitigation for adverse impacts to this property caused by the right-of-way acquisition and slope work under all alternatives includes minimizing acquisition and slope work, which limits impacts to the property.

4.11 Socio-Economic Impacts

■

4.11.1 Primary Impacts

4.11.1.1 Methodology

An assessment of the socio-economic impacts was performed for each alternative and option utilizing engineering drawings and maps of the study area at a scale of one inch equals 200 feet and through field surveys of the study area. The residential and commercial structures that would be acquired to construct any of the three full-Build Alternatives were determined. In most cases, the need to acquire the structure is due to its location within the proposed right-of-way, and in some cases, it is due to the loss of access. Structures were grouped into two categories: residential and business. Residential included all forms of housing, both single and multifamily, and business included all non-residential uses.

In general, the people in the households that may potentially be displaced appear to have the same social and economic characteristics as the rest of the residents in their towns of residency. The race, or ethnicity, of the potentially displaced persons also appears to be similar to the rest of the residents in their towns. Prior to the acquisition stage, special arrangements will be made to deal with the needs of the disabled or elderly people identified.

4.11.1.2 Property Purchase

There will be property purchased in connection with the alternatives and options being considered for planned improvements to I-93. Purchases involving the full acquisition of buildings and the relocation of homeowners or businesses are addressed in this section. The following Table 4.11-1 lists the required residential and business total property acquisitions related to the alternatives and options being considered for planned improvements to I-93. For more detailed information relative to these residential and business acquisitions, refer to Appendix H, NHDOT Conceptual Relocation Plan.

In the majority of cases, however, property to be purchased will not involve the acquisition of buildings and the relocation of businesses or homeowners. Such purchases involve the partial acquisition of properties, with the remaining property still available to serve a residential, commercial or industrial use in accordance with the applicable zoning. The acreage of land to be acquired in partial acquisitions is estimated in total to be 346 acres for Selected Alternative. Table 4.11-2 presents a breakdown by municipality of the partial acquisition acreage to be acquired. In general, the purchase of this property will adversely affect the value of the property with respect to property taxes, only to the degree that the use of the property is adversely affected.

Table 4.11-1
Residential and Business Total Property Acquisitions

Road Segment	Option	Three-Lane Alternative: Number of Residential Acquisitions	Three-Lane Alternative: Number of Business Acquisitions	Four-Lane Alternative[1]: Number of Residential Acquisition	Four-Lane Alternative[1]: Number of Business Acquisitions
A	**South of Cross Street**	1	0	**1**	**0**
B	Reconstruct	3	0	3	0
B	**Relocate**	4	0	**4**	**0**
C	Loop	4	1	4	1
C	**Diamond**	3	1	**3**	**1**
C	**Exit 2 Park & Ride (East of NB lanes)**	7	1	**7**	**1**
D	NB Shift (Option 1)	0	5	0	5
D	NB Shift (Option 2)	0	5	0	5
D	NB Shift (Option 3)	1	7	1	7
D	NB Shift (Option 4)	1	7	1	7
D	NB Shift (Option 5)	1	8	1	8
D	NB Shift (Option 6)	1	8	1	8
D	NB/SB Tight Shift (Option 7)	1	6	1	6
D	**NB/SB Tight Shift (Option 8)**	2	8	**2**	**8**
D	NB/SB Tight Shift (Option 9)	2	9	2	9
D	**Exit 3 Park & Ride (Between SB & NB lanes, or East of NB lanes)[2]**	1	0	**1**	0
E	**East**	3	2	**3**	**2**
E	West	3	2	3	2
F	Relocate NH 28	0	1	0	1
F	**Reconstruct NH 28**	0	0	**0**	**0**
F	Relocate NB Ramps	0	0	0	0
F	Park & Ride (Option 1: Adjacent to I-93 ROW)	0	1	0	1
F	Park & Ride (Option 2: Adjacent to Symmes Dr)	0	4	0	4
F	**Park & Ride (Option 2 Modified: Adjacent to Symmes Dr)**	0	2	**0**	**2**
F	Park & Ride (Option 3: Adjacent to Perkins Rd.)	0	0	0	0
F	Park & Ride (Option 4: SE quadrant)	0	1	0	1
F	Park & Ride (Option 5: NE quadrant)	1	0	1	0

1 Bold = Selected Alternative.
2 This acquisition is also included in Segment D, Options 7, 8 and 9.

Table 4.11-2
Partial Acquisitions for the Selected Alternative

Town	Acres
Salem	70
Windham	170
Derry	20
Londonderry	82
Manchester	4
Total	346

4.11.1.3 Demographic, Housing, and Employment

Direct impacts to local and regional demographics as a result of any of the full-Build Alternatives are not anticipated. The maximum number of residences to be displaced, considering all the options, is 22 residences for any of the full-Build Alternatives. At the average Salem-Windham family size of 3.2 persons, where the majority of potential relocations occur, this equates to a potential impact of 74 persons. This equals only 0.04 percent of the study corridor's 5-town total population of approximately 203,000. It is believed likely that any residential relocation caused by these alternatives and their options can be satisfied within the study area.

Relocation of displaced people to other areas within the corridor's study towns should not be hampered by the availability of safe and sanitary housing. Given that the scale of potential residential relocation is 18-22 units, and that the available housing stock in 2000 within the study area was approximately 2,950 units, there will be adequate replacement residential units available (Table 4.11-3). At the same time, new construction has continued to add units to the housing stock.

Table 4.11-3
Vacant Residential Units

	Vacant Residential Units	
Town	Number	Percent
Salem	464	4.3
Windham	338	8.7
Derry	408	3.2
Londonderry	95	1.2
Manchester	1,645	3.6
Total	2,950	

Source: 2000 US Census

Given the scale of residential displacement, there should be no substantial effect on the housing market in the neighborhoods to which the displaced people are likely to relocate.

The maximum number of relocated businesses, considering all the options, is 18 businesses for any of the full-Build Alternatives. It is believed likely that any business relocation caused by these alternatives and their options can also be satisfied within the study area. There also appears to be commercially zoned areas suitable for businesses being displaced by the widening and associated interchange reconstruction. The degree to which owners feel that available alternative sites are not suitable is a source of concern, particularly for such businesses that are heavily dependent on drive-by traffic (such as gas stations, fast food, etc.) or subject to permitting requirements.

In terms of addressing individual needs, refer to Section 4.11.1.7 Mitigation.

Therefore, no net impact to demographic, housing or employment levels are anticipated under any of the alternatives.

There may be secondary impacts to local and regional demographics, which are discussed in Section 4.12.

4.11.1.4 Existing Land Use Patterns

Existing land use patterns have been developed over time, influenced primarily by the real estate market, road access and local regulatory decisions, that is, zoning and other land use controls. Improvements to I-93 should not cause any fundamental shift in land use patterns. Development along the highway will likely continue to develop as it is today. Land in the area of interchanges will also continue to be developed as it has been.

Residential uses adjacent to interchanges will be under increasing pressure in regard to conversion to commercial or industrial use, and it will be up to the community to decide what changes may be appropriate. In the case of Salem, those residential areas near the proposed park-and-ride lots will be under increased pressure to be rezoned. The Town will likely resist this pressure. In the areas of Exits 3, 4 and 5, the current zoning will probably continue for the foreseeable future. Continued development and redevelopment are expected on commercially and industrially zoned property.

4.11.1.5 Community Facilities

Community facilities within the I-93 study corridor vary from community to community, but typically include such things as police and fire stations, schools, municipal buildings, post office, hospitals, libraries, public works facilities, waste

water treatment facilities, museums, cemeteries, airports, etc. There are no direct impacts to any of these types of community facilities.

4.11.1.6 Tax Base

Various potential alternative improvements to I-93 require the purchase of homes and businesses. One of the results of such purchases is to remove local real estate tax base from the community. The impact of this tax base loss is measured by totaling the assessed value represented by these purchased properties. Partial acquisitions are not included here because each remaining property is still available to serve a residential, commercial or industrial use, and still retains most of its assessed value.

The Three-Lane and Four-Lane Alternatives necessitate the purchase of the same properties. The optional improvements for each road segment, however, do necessitate that different properties be acquired. The following Table 4.11-4 lists the complete acquisitions and includes the NHDOT parcel number, the municipalities' tax parcel number by which the assessor knows the parcel, the parcel's use, the parcel's assessment as recorded in current (February 2002) tax assessment records, and the parcel's size. The total assessment is also provided for each particular improvement. The options making up the Selected Alternative are shown in bold type.

The total real property tax assessment value that will be removed from each community's tax base will vary depending upon the particular road improvement that is constructed. The range for the total five-community area varies from a low of about $8.4 million to a high of $15.3 million.

In Salem, for road segments A, B, C and the Exit 2 Park-and-Ride Lot, this assessed value of real property purchased will range from a low of $2.9 million to a high of $3.8 million. The Selected Alternative represents an assessed value of $3.1 million. In Windham, for highway segment D and the Exit 3 Park-and-Ride Lot, the assessed value of real property purchased will range from a low of $4.7 million to a high of $7.8 million. The Selected Alternative represents an assessed value of $6.3million. In Derry, for a portion of road segment E, the assessed value of real property purchased is approximately $0.5 million and does not vary by alternative. In Londonderry, for the remaining portion of road segment E, all of segment F and the Exit 5 Park-and-Ride Lot, the assessed value of real property purchased will range from a low of $0.3 million to a high of $3.2 million. The Selected Alternative represents an assessed value of $1.1 million. There are no complete acquisitions of property proposed in Manchester, so impacts to the tax base will be minimized.

The annual resultant lost tax revenue will depend upon each community's individual annual tax rate as applied to their lost assessment value. This loss takes place at the

Table 4.11-4
2002 Real Property Tax Assessments and Parcel Size

Town	Segment	Description/ Option[5]	NHDOT Parcel #	Town Tax Parcel #	Use[1]	Parcel Assessment $	Total Assessment $	Parcel Size	Total Acres
Salem	**A**	**South of Cross St**	**S-10**	**142-9335**	**R**	**143,700**	**143,700**	**0.54**	**0.54**
	B	Reconstruct	S-17	135-8922	R	191,300		1.94	
			S-37	134-8865	R	125,700		0.45	
			S-38	134-8866	V	59,200		1.92	
			S-42	134-1682	R	265,200	671,400	1.32	5.63
		Relocate	**S-17**	**135-8922**	**R**	**191,300**		**1.94**	
			S-37	**134-8865**	**R**	**125,700**		**0.45**	
			S-38	**134-8866**	**V**	**59,200**		**1.92**	
			S-42	**134-11682**	**R**	**265,200**		**1.32**	
			S-43	**134-11680**	**R**	**265,000**	**906,400**	**1.00**	**6.63**
	C	Loop	S-60	115-8763	R	125,100		0.20	
			S-69	115-7763	R	196,400		1.10	
			S-78	97-7851	R	633,400		8.55	
			S-81	97-7847	C	292,600		0.64	
			S-182	116-7758	R	222,400	1,469,900	1.00	11.49
		Diamond	**S-60**	**115-8763**	**R**	**125,100**		**0.20**	
			S-69	**115-7763**	**R**	**196,400**		**1.10**	
			S-81	**97-7847**	**C**	**292,600**		**0.64**	
			S-182	**116-7758**	**R**	**222,400**	**836,500**	**1.00**	**2.94**
		Exit 2 Park &) Ride (East of NB lanes	**S-151**	**97-4424**	**R**	**129,900**		**2.00**	
			S-152	**97-4423**	**R**	**119,500**		**0.51**	
			S-153	**97-4422**	**R**	**159,200**		**0.66**	
			S-154	**97-4421**	**V**	**51,400**		**0.57**	
			S-155	**97-4419**	**R**	**268,399**		**3.02**	
			S-156	**97-4417**	**V**	**4,900**		**0.43**	
			S-157	**97-4416**	**R**	**119,400**		**0.34**	
			S-158	**97-4415**	**R**	**104,800**		**0.34**	
			S-169	**97-7865**	**R**	**137,000**		**1.75**	
			S-173	**97-7866**	**C**	**155,900**	**1,250,399**	**1.62**	**11.24**
Windham	**D**	NB Shift #1 (Option 1)	W-46	11-C-1	V	101,000		0.38	
			W-47	11-C-6	V	77,000		1.20	
			W-93	12-K-1	V	400,000		10.76	
			W-95	12-A-550	C	932,000		1.70	
			W-99	17-G-2	C	550,000		1.03	
			W-100	17-G-1	C	816,000		2.66	
			W-104	17-G-45	C	168,000		0.97	
			W-105	17-G-41	C	379,000	3,423,000	1.27	19.97
		NB Shift #2 (Option 2)				Same as Option 1			
		NB Shift #3 (Option 3)	W-35	11-C-425	C	385,000		4.78	
			W-44	11-C-12	C	539,000		2.10	
			W-45	11-C-5	R	133,000		0.94	
			W-46	11-C-1	V	101,000		0.38	

Table 4.11-4 (continued)

Town	Segment	Description/ Option[5]	NHDOT Parcel #	Town Tax Parcel #	Use[1]	Parcel Assessment $	Total Assessment $	Parcel Size	Total Acres
			W-47	11-C-6	V	77,000		1.20	
			W-93	12-K-1	V	400,000		10.76	
			W-95	12-A-550	C	932,000		1.70	
			W-99	17-G-2	C	550,000		1.03	
			W-100	17-G-1	C	816,000		2.66	
			W-104	17-G-45	C	168,000		0.97	
			W-105	17-G-41	C	379,000	4,480,000	1.27	27.79
		NB Shift #4 (Option 4)				Same as Option 3			
		NB Shift #5 (Option 5)	W-35	11-C-425	C	385,000		4.78	
			W-43	11-C-13	C	600,000		1.49	
			W-44	11-C-12	C	539,000		2.10	
			W-45	11-C-5	R	133,000		0.94	
			W-46	11-C-1	V	101,000		0.38	
			W-47	11-C-6	V	77,000		1.20	
			W-93	12-K-1	V	400,000		10.76	
			W-95	12-A-550	C	932,000		1.70	
			W-99	17-G-2	C	550,000		1.03	
			W-100	17-G-1	C	816,000		2.66	
			W-104	17-G-45	C	168,000		0.97	
			W-105	17-G-41	C	379,000	5,080,000	1.27	29.28
		NB Shift #6 (Option 6)				Same as Option 5			
		NB/SB Tight Shift #7 (Option 7)	W-46	11-C-1	V	101,000		0.38	
			W-47	11-C-6	V	77,000		1.20	
			W-93	12-K-1	V	400,000		10.76	
			W-95	12-A-550	C	932,000		1.70	
			W-99	17-G-2	C	550,000		1.03	
			W-100	17-G-1	C	816,000		2.66	
			W-101[2]	17-G-6	V	252,400		7.48	
			W-102[3]	17-G-20	R	49,200		1.40	
			W-103	17-G-26	C	835,000		4.71	
			W-104	17-G-45	C	168,000		0.97	
			W-105	17-G-41	C	379,000		1.27	
			W-106	17-G-40	C	370,000	4,929,600	17.00	50.56
		NB/SB Tight Shift #8 (Option 8)	**W-35**	**11-C-425**	**C**	**385,000**		**4.78**	
			W-44	**11-C-12**	**C**	**539,000**		**2.10**	
			W-45	**11-C-5**	**R**	**133,000**		**0.94**	
			W-46	**11-C-1**	**V**	**101,000**		**0.38**	
			W-47	**11-C-6**	**V**	**77,000**		**1.20**	
			W-93	**12-K-1**	**V**	**400,000**		**10.76**	
			W-99	**17-G-2**	**C**	**550,000**		**1.03**	
			W-100	**17-G-1**	**C**	**816,000**		**2.66**	
			W-101[2]	**17-G-6**	**V**	**252,400**		**7.48**	
			W-102[3]	**17-G-20**	**R**	**49,200**		**1.40**	
			W-103	**17-G-26**	**C**	**835,000**		**4.11**	

Table 4.11-4 (continued)

Town	Segment	Description/ Option[5]	NHDOT Parcel #	Town Tax Parcel #	Use[1]	Parcel Assessment $	Total Assessment $	Parcel Size	Total Acres
			W-104	**17-G-45**	**C**	**168,000**		**0.97**	
			W-105	**17-G-41**	**C**	**379,000**		**1.27**	
			W-106	**17-G-40**	**C**	**370,000**	**5,054,600**	**17.00**	**56.08**
		NB/SB Tight Shift #9 (Option 9)	W-35	11-C-425	C	385,000		4.78	
			W-43	11-C-13	C	600,000		1.49	
			W-44	11-C-12	C	539,000		2.10	
			W-45	11-C-5	R	133,000		0.94	
			W-46	11-C-1	V	101,000		0.38	
			W-47	11-C-6	V	77,000		1.20	
			W-93	12-K-1	V	400,000		10.76	
			W-95	12-A-550	C	932,000		1.70	
			W-99	17-G-2	C	550,000		1.03	
			W-100	17-G-1	C	816,000		2.66	
			W-101[2]	17-G-6	V	252,400		7.48	
			W-102[3]	17-G-20	R	49,200		1.40	
			W-103	17-G-26	C	835,000		4.11	
			W-104	17-G-45	C	168,000		0.97	
			W-105	17-G-41	C	379,000		1.27	
			W-106	17-G-40	C	370,000	6,586,600	17.00	59.27
		Exit 3 Park & Ride (Between SB & NB lanes, or East of NB lanes	**W-101[2]**	**17-G-6**	**V**	**1,009,600**		**29.92**	
			W-102[3]	**17-G-20**	**R**	**246,000**	**1,255,600**	**7.48**	**37.40**
Derry/ Londonderry	**E**	**East**	**D-10**	**1-019-009**	**R**	**157,300**		**1.02**	
			D-11	**1-019-008**	**R**	**165,400**		**2.04**	
			D-24	**107-0218 A**	**C**	**138,900**		**0.00**	
			L-174	**10-86**	**C**	**137,900**		**1.70**	
			L-178	**10-149**	**R**	**131,600**	**731,100**	**2.00**	**6.76**
		West	D-10	1-019-009	R	157,300		1.02	
			D-11	1-019-008	R	165,400		2.04	
			D-24	107-0218A	C	138,900		0.00	
			L-37	10-26	R	146,600		1.11	
			L-174	10-86	C	137,900	746,100	1.70	5.87
Londonderry/ Manchester	**F**	Relocate NH 28	L-130	16-66	C	1,305,100	1,305,100	8.21	8.21
		Reconstruct NH 28	**-**	**-**	**-**	**-**	**0**	**-**	**0**
		Relocate NB Ramps	-	-	-	-	0	-	0

Table 4.11-4 (continued)

Town	Segment	Description/ Option	NHDOT Parcel #	Town Tax Parcel #	Use[1]	Parcel Assessment $	Total Assessment $	Parcel Size	Total Acres
		Exit 5 Park & Ride (Option #1: Adjacent to I-93 ROW)	L-82	15-56	C	1,332,300	1,332,200	12.79	12.79
		Exit 5 Park & Ride (Option #2: Adjacent to Symmes Dr)	L-75 L-79 L-80 L-81	15-61-1 15-61-5 15-61-4 15-58	C C V C	270,200 543,000 256,100 588,700	1,658,000	1.00 1.80 3.84	9.22
		Exit 5 Park & Ride (Option #2 Modified: Adjacent to Symmes Dr)	**L-79 L-80**	**15-61-5 15-61-4**	**C V**	**543,000 256,100**	**799,100**	**1.80 3.84**	**5.64**
		Exit 5 Park & Ride (Option #3 Adjacent to Perkins Rd)	No values, as this option does not include the acquisition of homes or businesses						
		Exit 5 Park & Ride (Option #4: SE quadrant)	L-129 L-130	16-73 16-66	 C	107,300 1,305,100	1,412,400	0.52 8.21	8.73
		Exit 5 Park & Ride (Option #5: NE quadrant)	L-97 L-98	16-9-1 16-9-2	R V	137,000 64,574[4]	210,574	1.00 16.00	17.00
			Selected Alternative Totals:				**10,977,399**		**127.23**

NOTES:
1 R Residential Use
C Commercial Use
V Vacant property
2 A complete acquisition, but divided between that purchased for segment option (20%) and that for park & ride lot (80%).
3 A large, but partial acquisition, divided between that purchased for segment option (10%) and that for park & ride lot (50%).
4 This property is classified as in Current Use and does not reflect a comparative assessed value.
5 Bold type indicates Selected Alternative.

time of NHDOT's property purchase. More specifically, the tax assessment and 2001 taxes for the Selected Alternative follow (Table 4.11-5).

This loss in assessed value is a very minor portion of the Towns' total assessed value and is expected to be offset over time by the new growth and redevelopment expected to take place within these corridor towns. In addition, improved transportation infrastructure and adequate operational capacity along the corridor and at the interchanges will likely contribute to increased property values, and promote new growth and redevelopment.

Table 4.11-5
Selected Alternative 2001 Real Property Tax by Town

Town	Segment	Proposed Acquired Properties Assessed Value $	Tax Rate	Taxes	Town Wide Assessed Value	% of Town Wide Value Lost
Salem	A	$143,700	$19.15/$1,000	$ 60,074	$2.52 billion	0.0024%
	B	$906,400	of assessed value			
	C	$836,500				
	Exit 2 P&R	$1,250,399				
Subtotal		$ 3,136,999				
Windham	D	$5,054,600	$17.45/$1,000	$ 110,113	$1.13 billion	0.0097%
	Exit 3 P&R	$1,255,600	of assessed value			
Subtotal		$ 6,310,200				
Derry	E	$ 461,600	$27.34/$1,000	$12,620	$1.85 billion	0.00068%
Subtotal		$461,600	of assessed value			
Londonderry	E	$269,500	$24.67/$1,000	$ 26,362	$1.60 billion	0.00160%
	F	0	of assessed value			
	Exit 5 P&R	$799,100				
Subtotal		$1,068,600				
Totals		$ 10,977,399		$ 209,169	$7.10 billion	0.0029%

4.11.1.7 Mitigation

Property requiring acquisition is appraised utilizing techniques recognized and accepted by the appraising profession and in conformity with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, and applicable to New Hampshire State Law. The amount offered for partial acquisitions is the difference between the fair market value of the property before the highway is built and its value after the portion needed for the highway has been acquired. Completed appraisals are carefully reviewed by an independent appraiser to insure that requirements of condemnation law and acceptable appraisal methods are met. The displaced residences will be eligible for relocation benefits, which include:

- Fair market value for acquired property
- Relocation advisory assistance services
- Payments for moving and relocation costs
- Replacement housing payments for home owners
- Residential mortgage interest differential payments and closing costs
- Replacement housing payments for tenants

The displaced businesses will be eligible for relocation benefits, which include:

- Fair market value for acquired property
- Relocation advisory assistance services
- Payments for actual reasonable moving
- Business re-establishment costs

Should identifying affordable housing for any residents displaced by the Selected Alternative (owners or renters) within the existing housing stock and assistance programs prove unfeasible, last resort housing will be made available, if necessary, in accordance with Section 206 of the Uniform Act and governing regulations. As part of the right-of-way acquisition process, particular attention will be given to the current residents of these properties to assure that the needs of the displacees are adequately addressed and the project will not knowingly discriminate against low-income and minority residents of the project area.

It is anticipated that the economic impacts associated with the business displacements, particularly in the Exit 3 interchange area, will, in the long run, be offset by redevelopment spurred by the improved traffic flow and accessibility. In the vicinity of Exit 3, the town of Windham has instituted a gateway zoning district in the vicinity of the proposed interchange configuration to foster desirable development. NHDOT will continue to coordinate with the communities to develop the project improvements in keeping with the individual communities' goals for potential redevelopment in impacted interchange areas.

As part of the Public Hearing process a number of owners of private residences and/or businesses requested that NHDOT acquire their properties even though they had not been identified for acquisition. These individuals felt they would be adversely affected by the project. The *Report of the Commissioner* (see Appendix I) provides details of the decisions relative to each of those requests.

■

4.11.2 Cumulative Impacts

Cumulative impacts are the aggregate of impacts or ramifications associated with the widening of I-93 with the impacts associated with other planned projects in the region. In a position paper entitled *Secondary and Cumulative Impact Assessment in the Highway Project Development Process (FHWA 1992)*, the following discussion of terminology is provided.

> Guidelines prepared by the Council on Environmental Quality (CEQ) for implementing NEPA broadly defined both secondary and cumulative impacts. Secondary effects are those that are "caused by the action and are later in time or further removed in distance but are still reasonably foreseeable" (40CFR 1508.8). Generally, these impacts are induced by the initial action. They comprise a wide variety of secondary effects such as

> changes in land use, water quality, economic vitality and population density. Cumulative effects are impacts which result from the incremental consequences of an action when added to other past and reasonably foreseeable future actions (40 CFR 1508.7). These impacts are less defined than secondary effects. The cumulative effects of an action may be undetectable when viewed in the individual context of direct and even secondary impacts, but nonetheless can add to other disturbances and eventually lead to a measurable environmental change.

The nature of secondary and cumulative impacts associated with future development makes them difficult to forecast or measure. Future land use is determined by many variables. Zoning, economic climate, community values, surrounding land use and regulations, as well as access, are all factors affecting future land use. Similarly, the same factors come into play when considering the possible other projects or developments of a regional nature that might come to fruition, contributing to cumulative impacts.

The issue of potential secondary land use impacts associated with the widening of I-93 is addressed in Section 4.12.1.

Typically, consideration of cumulative impacts involves identification of other projects or developments of regional importance. The impacts associated with these projects when combined with the impacts associated with the widening of I-93 need to be recognized for the potential ramifications involved. With that in mind, such projects would seemingly involve the recently completed NH 101 limited access freeway from Manchester to the NH seacoast and the ongoing expansion of the Manchester Airport and the new access road proposed from the FE Everett Turnpike as it passes through Bedford, NH; the recently completed widening of the southern end of the FE Everett Turnpike in Nashua, NH and the ongoing widening of the Middlesex Turnpike (US Route 3) in MA from the NH border to I-495 and I-95; the ongoing initiatives in the City of Manchester following the construction of a new civic center; and the potential for major outdoor sport facilities like the minor league ballpark proposal for Manchester's river front. There are also a number of ongoing and planned important transportation related improvements, including the anticipated revival of passenger train service from Nashua, NH to Lowell and Boston, MA with possible future extensions of the service up through Manchester; the possible future construction of a new Exit 4A Interchange along I-93 between Exits 4 and 5 providing traffic relief through downtown Derry and industrial expansion in the Derry/ Londonderry area east of I-93; the reconstruction and relocation of NH 111 east of I-93 Exit 3 Interchange in Windham, NH improving safety and capacity along this important east/west secondary highway; and future improvements to I-93 in northern MA as outlined in a study completed by the Merrimack Valley Planning Commission. In their totality, these projects in conjunction with the widening of I-93 from Salem to Manchester represent major improvements in infrastructure with long-term effects on the southeastern region of the State of New Hampshire.

Potential ramifications include the following:

- A greatly improved transportation system for the southern tier of NH, facilitating the movement of people, goods, and services with positive implications for employment and the State's overall economy.
- A stronger transportation relationship, both by road (including bus service) and airport, to the Boston, MA regional economy with its resulting economic strength and stability from increased diversity, resulting in a greater range of type of employment choices and a larger percentage of higher paying (technical and managerial) employment opportunities, but making quality education increasingly more important.
- Renewed growth and development pressures from regional sources with which local municipal planning and regulation mechanisms must deal, with assistance from state and regional planning organizations.
- Pressure for increased development density from infill development and redevelopment, particularly along the I-93 corridor, and greatest near its access points.
- Increased pressure for conversion to commercial and industrial land uses, particularly along the I-93 corridor, and greatest near its access points.
- A greater potential for additional separation of land uses within the corridor and the outlying towns, to the extent that Smart Growth principles are not embraced.
- Potential future water shortages relating to larger demand, limits to production and the protection of water resources.
- Potential loss of natural resources, such as open space and farmlands, from development.
- Potential need for additional public facilities to serve a larger residential and business population.
- Increasing property values from higher densities with which to fund additional public facilities, but also potentially increasing the burden on those with fixed incomes.
- The potential loss of those elements that define today's landscape creating a town's perceived small-town rural character, including for example: rural separations between towns, a small building scale, stone walls and narrow rural roads.

The potential ramification of these cumulative impacts will not necessarily be negative, but will depend upon state and local governments' comprehensive planning and response.

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4.11.3 Environmental Justice

Executive Order 12898 requires federal actions to address environmental justice in minority populations and low-income populations. This order requires the federal agencies, including the US Department of Transportation, to identify and address, as appropriate, their programs, policies or activities having disproportionately high and adverse human health or environmental effects on minority populations and low-income populations.

More specifically, projects having substantial effects on human health or the environment shall be undertaken in a manner that they do not have the effect of excluding persons from participation in, denying persons the benefits of or subjecting persons to discrimination because of their race, color or national origin.

This project does not create a new transportation corridor, and at most, calls for the purchase of 22 residential properties and 18 commercial properties, spread out over the entire (19.8 mile) length of the project. Given the reasonably high level of income, the general lack of minority or low-income populations within the study area, the few numbers of properties subject to complete acquisition and their dispersed nature along the study corridor, the provisions of Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, are not applicable to this project. Such populations are clearly not being disproportionately impacted by the alternatives being discussed in this DEIS.

In summary, therefore, this project does not affect singular areas or neighborhoods where populations of low income, or of specific races or color or national origin, live or work.

4.12 Secondary Land Use Impacts

■

4.12.1 Introduction

The purpose of this subsection is to evaluate the potential secondary land use impacts due to the proposed widening of I-93 between Salem and Manchester. The means by which these effects might be minimized or offset, as appropriate, also are discussed. As part of the evaluation, the general effects on environmental resources that would be most vulnerable to such secondary land use impacts are identified and discussed.

Secondary land use impacts are defined as those impacts caused by the proposed project that occur later in time and removed in distance, but are still reasonably foreseeable. For this project, secondary impacts may be more specifically defined as

those impacts that may result from the I-93 improvements outside of the direct (or primary) property and resource impacts within the highway corridor and the construction footprint. Such impacts may occur due to the increased traffic capacity of I-93 and the resultant improved accessibility within the area influenced by the I-93 corridor in New Hampshire. Secondary impacts to natural resources would typically result from the conversion of existing undeveloped lands that contain such resources to residential, industrial, commercial and governmental land uses. In addition, secondary impacts can have a positive impact to socio-economic resources in terms of improving the potential for more housing and employment opportunities.

The analysis of secondary impacts is an evolving art more than it is a science. Federal agencies such as the Council on Environmental Quality (CEQ) and the Federal Highway Administration (FHWA), while attempting to provide guidance, have concluded in position papers (FHWA April 1992) that there is no one correct way, nor a prescribed specific technique or method that must be used to conduct such analysis. Indeed, each secondary impacts analysis is tailored to the needs of a particular locale and project. Such is the case here. For this analysis, an Expert Panel was convened using a process known as the Delphi Technique[45] to allocate (not predict) future growth in the Study Area for the year 2020 for the No-Build and Build Alternatives. The Panel was used to provide an objective and independent view of the future of the Study Area; the process is explained in detail in Subsections 4.12.4 and 4.12.5.

The need for such analyses of secondary impacts has emerged because of the concern that increasing accessibility by improving transportation infrastructure can enhance development potential and the conversion of undeveloped land to urban and suburban land uses. Such has been the case nationwide with the completion of the Interstate Highway System and such has been the case in southern New Hampshire since I-93 was built in the late 1960's. Concurrent with other economic influences, the new highway helped spur development in its corridor.

Due to continued growth in the corridor and beyond, the design capacity of I-93's four travel lanes (two northbound and two southbound) is exceeded during peak periods in the Salem-Manchester segment. The currently proposed project, while clearly not as dramatic as the original construction in terms of increasing accessibility, is intended to increase capacity by adding lanes to the existing highway, as well as to improve safety. Today, the I-93 highway corridor is well established and characterized by widespread suburban development. Accordingly, the relative degree of secondary impacts in southern New Hampshire would be expected to be less substantial in the next 20 years than was the case after the new highway was built. For example, using the Expert Panel's blended average allocations (see Subsection 4.12.5) of future population and employment growth by 2020 in the

45 See Section 4.12-4 for description.

Secondary Impacts Study Area, the additional growth with the Build Alternative over the No-Build Alternative is in the 5 percent range.

Nevertheless, concern has been expressed that the suburban sprawl pattern of development would continue as a result of improved highway capacity and incremental decision-making by local communities in the Secondary Impacts Study Area (see definition in Subsection 4.12.3). To assess this concern and meet the requirements of the National Environmental Policy Act (NEPA) of 1969, potential secondary land use impacts have been considered and presented below.

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4.12.2 Alternatives Considered

For the secondary land use impacts study, a No-Build Alternative and a full Build Alternative were considered. The full Build Alternative considered assumed the addition of two travel lanes to each of the existing northbound and southbound barrels between Salem at the Massachusetts State Line and Manchester at I-293. While space for a possible future rail line is provided in the design of the highway widening, passenger rail service in this highway corridor is not proposed at this time. All five existing interchanges in this highway segment are assumed to be improved, but no additional interchanges are proposed.

The No-Build Alternative assumed that no capacity improvements or substantial safety improvements would be constructed along I-93 from Salem to Manchester. Other highway and other transportation improvements as outlined in the State's Ten-Year Transportation Improvement Program were assumed to go forward to construction.

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4.12.3 Definition of Secondary Impacts Study Area

The Secondary Impacts Study Area includes the five communities in which the I-93 improvements would be constructed as well as 24 others in the region between Tewksbury and Andover in Massachusetts to the south and Concord, NH to the north. The Study Area covers approximately 824 square miles.

The extent of the Study Area was initially based on recommendations provided by the Oversight Committee made up of representatives of several State and Federal Agencies and New Hampshire regional planning commissions (RPCs). Using a previous origin and destination survey and the expertise and knowledge of the Committee, a Study Area of 29 communities was proposed. The Study Area was the subject of further consideration by the members of the Expert Panel enjoined to consider the magnitude of potential growth in the region.

Discussion of secondary impacts is presented by addressing the five corridor towns in which I-93 is located and the remaining towns grouped by their regional planning

agency area and then population size. See Table 4.12.1 and **Figure 4.12-1**, respectively, for a list and locations of the communities in the Study Area.

In addition, secondary impacts are discussed in a more general manner for three towns adjacent to and north of the Study Area: Canterbury, Boscawen and Loudon, as well as for three large regions still farther north of the Study Area: Dartmouth-Sunapee, North Country and Lakes Region. Three members of the Expert Panel suggested these additional areas.

Table 4.12-1
Secondary Impacts Study Area Municipalities by Area and Regional Planning Agencies (RPA)

Area	RPA	Municipalities
I-93 Project Corridor	Rockingham Planning Commission	Salem, Windham
	Southern NH Planning Commission	Derry, Londonderry, Manchester
New Hampshire (Study Area excluding I-93 Project Corridor)	Central NH Planning Commission	Allenstown, Bow, Concord, Dunbarton, Pembroke
	Nashua Regional Planning Commission	Pelham
	Rockingham Planning Commission	Atkinson, Danville, Hampstead, Sandown
	Southern NH Planning Commission	Auburn, Bedford, Candia, Chester, Deerfield, Goffstown, Hooksett, Raymond
Massachusetts (Study Area)	Merrimack Valley Planning Commission	Andover, Lawrence, Methuen, North Andover
	Northern Middlesex Council of Governments	Dracut, Tewksbury

■

4.12.4 Expert Panel

An Expert Panel was used to estimate population and employment, which in turn were used as indicators to estimate secondary land use impacts. The process through which the individual panelists provided their assessment of growth involved the "Delphi Technique." A Delphi is a structured process in which participants (the Panel) provide their assessment of likely future events (in this case the impacts of potential transportation investments) by responding to several rounds of questionnaires or surveys. A moderator tallies and summarizes the results of each round and provides these results back to the panelists. The Panel members are then given an opportunity to revise their initial analyses based on a review of their fellow panelists' work. The Delphi is considered complete when the responses in repeated rounds of questioning do not markedly change. The panelists typically conduct their work independently and somewhat anonymously in an effort to allow for fully reflective responses to the survey question and subsequent responses.

The Panel members were selected from the following relevant professional and public interest groupings because of their knowledge about local and regional planning, development, and/or the influence of growth pressure:

- Real estate including economic analysis, law and finance;
- Academia including planning and environmental resource analysis representing the Universities of Massachusetts and New Hampshire; other professions involving regional planning, town planning and public utilities;
- Environmental policy represented by public interest groups; and informed citizens from local planning boards and a regional water pollution agency.

The Project's Oversight Committee (convened by NHDOT), representing several State and Federal agencies and local officials suggested over 40 names of candidate panelists. All candidates were interviewed by telephone and 16 panelists were recommended, which resulted in the Panel selected.

The panelists were familiar with the corridor and the Study Area and each brought different strengths and areas of knowledge to bear for this task. Data and information were gathered and compiled in a briefing book to provide each Panel member with a common foundation of knowledge about the I-93 project and the proposed Study Area. The briefing book contained data, maps and information about the Study Area needed by the Panel to conduct their analysis. The data were gathered from a wide variety of sources including the following: New Hampshire agencies including the Office of State Planning (OSP), Department of Environmental Services (DES) and the Department of Employment Security; the Massachusetts Geographic Information System (MassGIS) and the Massachusetts Institute for Social and Economic Research (MISER); the U.S. Bureau of Census and Department of Commerce; as well as the Urban Land Institute and recent market analysis of office park developments in New England. The University of New Hampshire Complex Systems Research Center at Durham provided data that it maintains as part of GRANIT, the Statewide GIS program. The data were used to prepare color maps for analytical and comparison purposes using GIS software.

As a prelude to the process, a kick-off meeting was held at the University of New Hampshire, Manchester on June 29, 2001 to explain and provide background information on the I-93 Project, explain the Delphi process, and provide the Panel the opportunity to ask questions before they began their analysis. The general public was invited to attend this and the two subsequent meetings of the Panel on October 27, 2001 and December 5, 2001.

The expert panel process had two distinct phases. The first phase consisted of an assessment of the likely growth within the 29 communities that would result under a No-Build Alternative. The second phase involved performing a similar assessment for the Build Alternative. The Panel assessed this development by allocating population and employment among the 29 municipalities. Two panelists included the additional towns of Boscawen, Canterbury, and Loudon and allocated population and employment accordingly.

Detailed information about the Panel's work is included in the "I-93 Manchester to Salem Expert Panel Analysis Final Report, December 28, 2001 (revised January 22, 2001.")

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4.12.5 Panel's Blended Average Allocations

As noted above, each phase consisted of two rounds. After each round all the panelists' allocations were summarized and presented to the other panelists anonymously along with the memos each panelist wrote to summarize their thoughts behind the allocations. After the first round of each phase, the panelists could reallocate population and employment after seeing other panelists' allocations and memos. At the end of each round, the panelists' allocations were summarized using a "blended" average. This figure averages the median and mean of each phase's allocation. By using the blended average, weight is given to the very high or low panelist allocations, but not as much as using the mean directly. Coincidentally, the Panel's blended average allocation for growth by 2020 under the No-Build Alternative is roughly equal to the 2020 projections of the OSP.

Table 4.12-2 computes the difference in the Panels' blended average allocations for the No-Build and Build Alternatives in 2020. The differences between the Panel's employment and population allocations, which are shown in **Figures 4.12-2 and 4.12-3**, are used as the base for land conversion evaluations. In general, the Panel's blended average allocation suggests that the proposed project would have a greater influence on residential growth than commercial and industrial growth in the Study Area by 2020.

As was noted by the panelists at the December 5, 2001 meeting, the individual panelists' findings represent "informed opinions" which cross a broad spectrum ranging from large additional increases in growth if the highway is widened to no additional increase in growth associated with the widening. The panelists provided individual opinions and not a group consensus. As such, the blended average allocation represents one convenient measure by which to consider the findings.

With that said, the blended average allocations in total for the entire 29-community Study Area indicates that the Build Alternative would result in an additional 5 percent increase in both population and employment growth. Leaving out the allocations specific to Massachusetts (MA), the Build Alternative would result in an additional seven percent growth in both population and employment in New

Table 4.12-2
Expert Panel Blended Average Allocations for Population and Employment in 2020 in the Secondary Impacts Study Area by Alternative

	Current (2000)		No-Build Alternative (2020)		Build Alternative (2020)		No-Build to Build Difference	
Municipality	Population	Employment	Population	Employment	Population	Employment	Population	Employment
Allenstown	5,000	400	5,971	610	6,472	711	501	101
Andover, MA	31,000	18,000	36,999	22,718	37,616	23,705	617	987
Atkinson	6,000	400	8,573	673	9,757	875	1,184	201
Auburn	5,000	400	7,133	825	8,865	1,047	1,732	221
Bedford	18,000	12,000	24,906	19,932	27,186	21,300	2,279	1,368
Bow	7,000	3,000	9,264	4,339	10,237	5,003	974	664
Candia	4,000	300	5,408	449	6,425	601	1,016	152
Chester	4,000	200	5,623	323	6,369	400	746	77
Concord	41,000	45,000	48,253	59,609	50,997	61,052	2,745	1,443
Danville	4,000	200	5,584	319	6,085	340	501	21
Deerfield	4,000	200	5,543	321	5,989	383	445	61
Derry	34,000	7,000	44,706	9,009	47,672	9,876	2,966	867
Dracut, MA	29,000	7,000	34,018	9,268	34,676	9,651	658	383
Dunbarton	2,000	100	2,765	214	3,061	284	295	71
Goffstown	17,000	3,000	21,394	4,523	23,328	4,913	1,934	390
Hampstead	8,000	1,000	12,520	1,870	13,970	2,041	1,450	171
Hooksett	12,000	6,000	15,794	8,555	17,455	9,497	1,661	942
Lawrence, MA	72,000	31,000	80,501	38,332	81,429	39,583	928	1,251
Londonderry	23,000	8,000	33,069	11,700	37,250	12,583	4,181	883
Manchester	107,000	60,000	117,672	82,182	121,438	87,883	3,766	5,702
Methuen, MA	44,000	35,000	50,917	41,691	52,304	43,355	1,387	1,664
North Andover, MA	27,000	31,000	31,842	36,391	32,856	37,644	1,014	1,253
Pelham	11,000	2,000	16,973	2,800	18,911	3,165	1,938	365
Pembroke	7,000	2,000	8,866	2,941	9,570	3,095	704	155
Raymond	10,000	2,000	13,723	3,313	14,600	3,464	877	152
Salem	28,000	13,000	37,774	17,864	39,587	19,008	1,813	1,145
Sandown	5,000	100	7,814	209	8,174	251	360	41
Tewksbury, MA	29,000	9,000	34,392	14,359	35,100	14,696	708	337
Windham	11,000	1,000	15,047	1,986	16,294	2,446	1,246	460
TOTAL	605,000	298,300	743,045	397,324	783,671	418,852	40,626	21,527

Hampshire. Considering just the 13 New Hampshire towns with current populations of 10,000 people or less, the 2000 population of 71,000 people increases under the No-Build Alternative to approximately 99,000 people, and under the Build Alternative, to 110,000 people. The Build Alternative would result in an additional 12 percent growth in population and 13 percent growth in employment. These smaller New Hampshire towns are located along the periphery of the Study Area, particularly in the north. On the other hand, for the five New Hampshire municipalities with current populations greater than 20,000, the 2000 population of 233,000 people increases under the No-Build Alternative to approximately 281,000 people, and under the Build, to approximately 297,000 people. The Build Alternative would result in an additional 6 percent growth in both population and employment.

In addition, the widening is expected to affect growth in New Hampshire more than in Massachusetts, although the six Massachusetts municipalities would experience some additional growth in population (2 percent) and employment (4 percent). The widening also is expected to result in a greater percentage of growth for the smaller more rural New Hampshire communities and somewhat smaller percentage of growth for the larger more urbanized New Hampshire communities.

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4.12.6 Land Conversion

In order to estimate the potential effect of secondary land use development on environmental resources in the Study Area, the following procedure was used:

- Conversion of the Panel's blended average allocations for population and employment growth by 2020 into land area needed (in acres) to accommodate consequent secondary land use development;

- Identification of the amount of available developable land in each ommunity based on a review of community Master Plans and available buildout analyses. (Twelve of the 29 communities in the Study Area had calculated the remaining developable land in acres (see Table 4.12-4) and some had indicated this amount in their Master Plans. These calculations were based on a buildout analysis. The purpose of a buildout analysis is to indicate a view of the future which describes community development when permitted densities are fully realized under existing zoning and subdivision bylaws. The buildable area in most cases was assumed to be land areas remaining from which a number of development constraints (i.e., unbuildable lands) are subtracted. These constraints include internal roadways rights of way, wetlands and floodplains, preserved and protected open spaces, infrastructure factors, i.e., water and sewer services, and development density.)

- Identification of the general location of where this secondary growth is officially desired as indicated by future land use plans (if included as part of the adopted master plan) and zoning district maps;

- Identification of the general locations of environmental resources in the Study Area using available GIS data; and

- Qualitative observation of whether the secondary land use development would affect these resources.

The following two subsections explain how the Panel's allocations were converted to acres of consequent residential, commercial, industrial and other land use development. The methodology described below was developed for unique application for this study by Parsons Brinckerhoff Quade and Douglas, Inc. (PB). PB consulted its own land use experts throughout the U.S., the Urban Land Institute (Washington, DC), the American Planning Association (Chicago) and Bonz and Company, a Boston-based real estate economic consultant to identify a national or regional index that may be used to calculate land absorption to accommodate future allocations of population and employment. Since no reliable index was available, these sources agreed that applying the PB methodology was reasonable based on zoning rather than applying a per capita index. They cautioned that the use of any index such as acres per capita absorbed over time should not be used because inputs to such indices vary depending on the source, the purpose, and may be too gross an indicator in a specific area.

4.12.6.1 Residential Land Conversion Assumptions

Local zoning data were analyzed to calculate an average lot size for single and multi-family development for each municipality. Zoning was used since it is the primary legal land use and density control officially delegated to local governments from the states. Existing density of development allowed by present zoning is assumed to be the same in 2020. The average lot size was used to convert the Panel's average blended allocations for population into the amount of land (in acres) required to accommodate the consequent residential development. It should be pointed out that the Panel was not given an upper limit for their allocations and in some cases may have allocated more people than buildout scenarios indicate.

Through the regional planning commissions, zoning data were provided for the towns in New Hampshire and the average single family and multi-family lot size according to each town's zoning were determined. The number of housing units in each town in the Study Area in 1998 was determined using housing permit data provided by the OSP through GRANIT. It is assumed for this analysis that the proportional mix of single family, multi-family, and manufactured housing in each town in 1998 will be the same in 2020. In the case of Bedford, a review of its 2001 master plan update indicates no future growth in multi-family housing and the calculations take this into consideration.

The six municipalities in the Massachusetts portion of the Study Area have completed buildout analyses. Rather than use zoning data to compute average lot size, the data

from the buildout analyses were used in these communities for this calculation. These analyses compute the number of single and multi-family housing units in each community that would be required to reach total buildout. It is assumed that future development will be consistent with the percentage of each type of housing calculated in the buildout scenarios.

Household size has been decreasing in the Study Area since at least the 1980 census, though the rate of decrease has been slowing over time. To reflect this trend, it was assumed that the average household size in each municipality in the Study Area would be approximately 0.05 person less in 2020 than that recorded in the 2000 U.S. Census. The Panel's blended average allocation for population in 2020 was divided by the reduced household size to estimate the number of housing units needed to accommodate the allocated growth for the No Build and Build Alternatives.

For each municipality the average lot size for single family, multi-family and manufactured housing was multiplied by the number of units needed and then weighted by the proportion of that type of housing in the municipalities' housing stock. The three numbers were then added together to determine the estimated number of acres required to accommodate secondary residential growth.

Although average lot size consistent with zoning is a logical tool to use to calculate the amount of land required to accommodate secondary growth, the amount of land disturbed or actually "developed" on a given lot (for buildings, lawn, driveways, pool, etc.) will be far less than total lot size. This is particularly relevant with large lot zoning, which is standard in the Study Area. For example, 23 of the 29 municipalities in the Study Area have single family zoning districts with lot sizes of 1 acre or larger; 11 of these have minimum lot sizes of 2 or more acres. Typically, construction of a single family residence "develops" or uses a portion of the parcel, perhaps 0.25 to .50 acres, with the rest of the parcel area remaining "undeveloped" or maintained as natural growth, forest, or wetland areas. This is especially evident for lot sizes larger than one acre. As a result, zoning used in this analysis provides a maximum estimate of how many acres would actually be removed from a natural state due to expected growth and potential secondary growth.

Based on the above assumptions and analyses, nearly 61,000 acres would be converted or committed to residential development in the 29-community Study Area by 2020 whether the highway is widened or not, and an additional 20,000 acres would be converted due to secondary impacts of the Build Alternative. (See Table 4.12-4.) It is important to note, however, that the actual amount of land affected could be in the 25 to 50 percent range of the overall amount.

Table 4.12-3
Household Size Trends, 1990-2000, % Distribution of Housing Types in 1998 and Average Residential Lot Size (Acres)

Town	1990 Census Average Household Size	2000 Census Average Household Size	1998 % Single Family Housing[1]	1998 % Multi Family Housing[1]	1998 % Manufactured Housing[1]	Single Family Lot Size[2]	Multifamily Lot Size[3]	Manufactured Lot Size
Allenstown	2.64	2.53	36.73%	26.79%	36.48%	2.0	1	0.15
Andover, Ma	2.80	2.74	94.00%	6.00%	0.00%	0.9	0.08	0.15
Atkinson	2.92	2.66	76.78%	22.67%	0.54%	2.0	0.25	0.15
Auburn	3.14	2.96	94.11%	4.16%	1.73%	2.5	1.25	0.15
Bedford	3.07	2.85	84.49%	14.96%	0.54%	2.1	N/A[4]	N/A[4]
Bow	3.03	3.10	98.48%	1.30%	0.22%	3.0	1.5	0.15
Candia	3.07	2.88	89.90%	5.50%	4.60%	2.5	1.25	0.15
Chester	3.07	3.09	89.70%	7.41%	2.88%	2.3	1.15	0.15
Concord	2.35	2.30	39.50%	52.84%	7.67%	0.5	0.1	0.15
Danville	2.83	2.82	73.95%	5.53%	20.53%	2.0	1.25	0.15
Deerfield	3.09	2.98	85.50%	5.65%	8.86%	3.0	1.5	0.15
Derry	2.73	2.74	50.52%	45.02%	4.46%	1.1	0.55	0.15
Dracut, MA	2.85	2.73	83.88%	16.12%	0.00%	1.0	0.38	0.15
Dunbarton	2.74	2.73	91.48%	5.87%	2.65%	5.0	2	0.15
Goffstown	2.71	2.64	68.73%	25.92%	5.35%	0.9	0.45	0.15
Hampstead	2.85	2.72	74.33%	17.58%	8.09%	1.1	0.55	0.15
Hooksett	2.70	2.63	62.21%	29.27%	8.52%	2.6	1.3	0.15
Lawrence, MA	2.83	2.90	64.00%	36.00%	1.00%	0.2	0.1	0.15
Londonderry	3.10	3.05	68.22%	24.14%	7.64%	1.0	0.5	0.15
Manchester	2.40	2.36	36.06%	62.88%	1.07%	0.5	0.25	0.15
Methuen, MA	2.69	2.62	88.00%	12.00%	0.00%	1.1	0.2	0.15
North Andover, MA	2.71	2.61	99.00%	1.00%	0.00%	1.4	0.25	0.15
Pelham	3.24	3.03	85.54%	13.62%	0.84%	2.1	0.5	0.15
Pembroke	2.68	2.59	59.33%	36.20%	4.47%	1.8	1.6	0.15
Raymond	2.91	2.77	57.56%	19.77%	22.68%	1.1	0.55	0.15
Salem	2.79	2.69	68.77%	23.13%	8.10%	0.6	0.43	0.15
Sandown	3.11	3.02	84.77%	9.63%	5.59%	3.0	1.5	0.15
Tewksbury, MA	3.02	2.81	86.19%	13.81%	0.00%	1.0	0.1	0.15
Windham	3.15	2.98	91.71%	7.98%	0.31%	1.1	0.5	0.15

1 Original Data Source: For NH municipalities, NH Office of State Planning. For MA municipalities, buildout surveys were used to compute this housing mix.
2 Single-family default is .5 in cities AND 3 elsewhere if zoning not available from RPCs or GRANIT.
3 Multifamily Lot Size defaults to .25 ac. for Manchester and .5 ac. elsewhere if zoning data not available.
4 N/A: Not Applicable. The 2001 Master Plan update for Bedford indicates that are no more multi-family and manufactured residential lots available.

Table 4.12-4
Differences between Alternatives, Acres of Land Converted to Residential Development to Accommodate Panel's Blended Average Allocations for Population in 2020

Town	Total Town Area in Acres	Developable Land Available in Acres[1]	No-Build Population Growth (2000-2020)	No-Build Residential Land Conversion (Acres)[2]	No-Build to Build Population Difference	No-Build to Build Residential Land Conversion (Acres)[2]
Allenstown	13,167		971	455	501	235
Andover, MA	20,583	4,743	5,999	1,993	617	205
Atkinson	7,258		2,573	1,728	1,184	795
Auburn	18,438	8,652	2,133	1,941	1,732	1,576
Bedford	21,156	5,700	6,906	5,698	2,279	1,881
Bow	18,269		2,264	2,428	974	1,044
Candia	19,557		1,408	1,272	1,016	918
Chester	16,718	6,664	1,623	1,264	746	581
Concord	43,000		7,253	928	2,745	351
Danville	7,569		1,584	993	501	314
Deerfield	33,348	15,521	1,543	1,543	445	445
Derry	23,226	6,100	10,706	3,546	2,966	983
Dracut, MA	13,699	4,988	5,018	1,767	658	232
Dunbarton	20,046		765	1,475	295	569
Goffstown	24,065		4,394	1,387	1,934	610
Hampstead	9,014		4,520	1,725	1,450	554
Hooksett	23,761		3,794	3,223	1,661	1,411
Lawrence, MA	4,753	211	8,501	620	928	68
Londonderry	26,958	7,185	10,069	3,007	4,181	1,248
Manchester	22,355		10,672	1,723	3,766	608
Methuen, MA	14,722	2,425	6,917	2,794	1,387	560
North Andover, MA	17,706	3,188	4,842	4,786	1,014	583
Pelham	17,151		5,973	4,113	1,938	1,335
Pembroke	14,597		1,866	1,312	704	495
Raymond	18,943		3,723	1,168	877	275
Salem	16,569		9,774	2,051	1,813	380
Sandown	9,232		2,814	2,810	360	359
Tewksbury, MA	13,526	1,712	5,392	1,905	708	250
Windham	17,772		4,047	1,594	1,246	491
TOTAL[3]	**527,158**	**N/A[3]**	**138,045**	**60,563**	**40,626**	**19,356**

1 Developable Land Available from Regional Planning Commissions or individual towns, if available.
2 Residential Land Conversion = Population growth in households X average lot size X 1.1 (to estimate an additional 10% of acreage would be needed for roads or other ROW).
3 N/A Total not applicable since data were unavailable for all towns listed in column.

4.12.6.2 Commercial/Industrial Land Conversion Assumptions

Commercial and industrial land conversions were computed in a range for each community as employees per acre is heavily dependent on both the specific type of activity and the number of scheduled shifts of workers. Employment in the Study Area can be classified as belonging to one of the following four general categories:

- Manufacturing,
- Warehouse/distribution/construction/transportation,
- Office/R&D/flexible space/finance/government, and
- Service/retail.

Using 1999 county level data for employment by sector from the U.S. Department of Commerce as a reference, these categories are assumed to represent 15, 15, 20 and 50 percent of future jobs, respectively, in the Study Area in 2020.

The employees per acre for each category of employment were determined from referencing many sources, notably Urban Land Institute data and recent market analyses of office parks in New England. A low and high range of acreage was computed for each community. The Panel's blended average allocation was divided by the high and low number of employees per acre for each type of employment and multiplied by the percentage of employment represented by each type of employment. The numbers were added together to compute the range of land required for commercial, industrial and governmental growth for each municipality.

Please note that the land conversions for commercial and industrial development also include governmental development in this analysis. The estimates of land area required for the above uses are considered at the high end of a range because redevelopment of existing sites and growth in existing structures have not been specifically factored into this analysis. For example, redevelopment of existing sites such as industries that would expand on their present site and in existing buildings, such as mills, which may also be attractive to smaller companies, were not assumed in the conversion calculations.

Table 4.12-5
Differences between Alternatives, Acres of Land Converted to Accommodate Panel's Blended Average Allocations for Employment in 2020

			No-Build Alternative			Additional with Build Alternative		
Town	Total Acres	Developable Land Available	Employment Growth	Acres at Low Density	Acres at High Density	Employment Growth	Acres at Low Density	Acres at High Density
Allenstown	13,167		210	8	5	101	4	2
Andover, MA	20,583	4,743	4,718	190	105	987	40	22
Atkinson	7,258		273	11	6	201	8	4
Auburn	18,438	8,652	425	17	9	221	9	5
Bedford	21,156	5,700	7,932	320	176	1368	55	30
Bow	18,269		1,339	54	30	664	27	15
Candia	19,557		149	6	3	152	6	3
Chester	16,718		123	5	3	77	3	2
Concord	43,000	6,664	14,609	589	325	1443	58	32
Danville	7,569		119	5	3	21	1	0
Deerfield	33,348	15,521	121	5	3	61	2	1
Derry	23,226	6,100	2,009	81	45	867	35	19
Dracut, MA	13,699	4,988	2,268	91	50	383	15	9
Dunbarton	20,046		114	5	3	71	3	2
Goffstown	24,065		1,523	61	34	390	16	9
Hampstead	9,014		870	35	19	171	7	4
Hooksett	23,761		2,555	103	57	942	38	21
Lawrence, MA	4,753	211	7,332	295	163	1251	50	28
Londonderry	26,958	7,185	3,700	149	82	883	36	20
Manchester	22,355		22,182	894	493	5702	230	127
Methuen, MA	14,722	2,425	6,691	270	149	1664	67	37
North Andover, MA	17,706	3,188	5,391	217	120	1253	50	28
Pelham	17,151		800	32	18	365	15	8
Pembroke	14,597		941	38	21	155	6	3
Raymond	18,943		1,313	53	29	152	6	3
Salem	16,569		4,864	196	108	1145	46	25
Sandown	9,232		109	4	2	41	1	1
Tewksbury, MA	13,526	1,712	5,359	216	119	337	14	7
Windham	17,772		986	40	22	460	19	10
TOTAL	527,158	N/A	99,024	3,989	2,203	21,527	867	479

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4.12.7 Locations of Growth

The following categorizes and describes allocated growth for municipalities in the Study Area. The amount of growth described is the difference between the Expert Panel's blended average allocations for population and employment in 2020 for the Build and No-Build Alternatives. A category of "Other Areas" outside the secondary study area, as defined by several Panel members as already mentioned, is also included.

In general, the largest absolute growth in jobs and population would occur in the cities and large towns in the Study Area, whereas the largest percent change in growth would occur in the more rural municipalities away from the corridor.

For discussion purposes, the municipalities in the Study Area are considered in various groupings such as by state, corridor communities, population size, and regional planning agency service area. The number of people, jobs and acres involved has been rounded to the nearest 100 since absolute precision is unnecessary for this type of conceptual analysis. These data have been summarized by the various groupings and are shown in Tables 4.12-6 and 4.12-7.

In general, the locations of secondary land use development within the municipalities in the Study Area is predicated on local land use policy as reflected in local master plans and zoning. However, many of the local master plans do not include a future land use plan, so in these cases it is difficult to predict where local future growth would occur. In these situations, it is assumed that future development patterns will follow past trends, resulting in a combination of infill development and new development on the periphery of already developed areas and strip commercial development along major roads. In either case, the location of growth and secondary growth is under the control of local government. Land use decisions are made by them based on local priorities at the time.

Massachusetts Municipalities

The Panel's blended average allocations show relatively modest population growth in the six Massachusetts municipalities in the Study Area as compared to the New Hampshire communities; only 5,300 more people are allocated with the Build Alternative than with the No-Build Alternative. In general, these municipalities are nearing buildout and are being developed at a higher density than most of the New Hampshire Study Area communities. Andover, Dracut, Lawrence, Methuen, North Andover and Tewksbury would require approximately 2,200 more acres of land, in total, to accommodate allocated residential growth with the Build Alternative.

Table 4.12-6
Additional Population and Employment and Acres Needed for Build Alternative over No-Build Alternative, 2020

Geographic Grouping	Population	Acres	Employment	Acres[1]
Study Area (29 Communities)	40, 600	19,400	21,500	500-900
MA (6)	5,300	2,200	5,900	130-240
NH (23)	35,300	17,500	15,700	350-610
NH Corridor Communities (5)	14,000	3,700	9,100	200-400
NH Non-Corridor Communities (18)	21,300	13,700	6,600	100-300
NH Regional Planning Commissions				
Nashua Region PC (1)	1,900	1,300	370	10-15
Rockingham PC (6)	6,600	2,900	2,000	45-81
Southern NH PC (11)	21,600	10,500	10,800	200-400
Central NH PC (5)	5,200	2,700	2,400	50-100

1 Depending on density of development.

Table 4.12-7
Additional Population, Employment and Acres Needed by Size of Communities in New Hampshire, No Build and Build Alternatives, 2020

	Population Increase			Acres Needed		
Size of Communities	No Build	Plus Build	Total	No Build	Plus Build	Total
Less than 10,000 Pop. (13 communities))	27,800	10,800	38,600	19,400	8,200	27,600
10,000-20,000 (5)	25,100	9,100	34,200	16,000	5,700	21,700
More Than 20,000 (5)	48,500	15,500	64,000	11,300	3,600	14,900

The conversion of the Panel's average blended allocation to acres required may exceed the buildout scenarios in some communities that were previously prepared by the local regional planning commissions. This is the case in four large Massachusetts municipalities (Lawrence, Methuen, North Andover and Tewksbury) where there seemingly is not enough developable acres remaining to accommodate either the No-Build or the Build allocations by the Panel. Some of this additional growth, however, could be accommodated by re-use of existing facilities in these communities, for which there is ample precedent in the Merrimack Valley.

The six Massachusetts communities would have approximately 5,900 more jobs with the Build Alternative than with the No-Build Alternative, according to the Panel's blended average employment allocations. Approximately 130 to 240 acres would be required to accommodate secondary commercial and industrial land uses. Methuen,

Andover and Lawrence would gain more jobs than the other communities and the growth could be accommodated based on the current industrial and commercial land use patterns and zoning.

New Hampshire Municipalities

In the 23 New Hampshire municipalities in the Study Area, approximately 35,300 more residents would be added by 2020 with the Build Alternative than with the No-Build Alternative, according to the Panel's allocations. This growth ranges from 295 persons in Dunbarton to nearly 4,200 persons in Londonderry. To accommodate this population, secondary residential development would involve approximately 17,500 more acres in total.

Approximately 15,700 more jobs would be added to these communities by 2020 with the Build Alternative than with the No-Build Alternative. To accommodate these new jobs in commercial, industrial and governmental developments the approximate amount of undeveloped land to be converted is between 350 and 610 acres in total.

New Hampshire Project Corridor Municipalities

Using the Panel's blended average allocations, the five project corridor municipalities of Salem, Windham, Derry, Londonderry, and Manchester in total would experience population growth of approximately 14,000 more people with the Build Alternative than with the No-Build Alternative. This growth ranges from over 1,200 in Windham to nearly 4,200 in Londonderry. Based on the residential land conversion assumptions and methodology described in Section 4.12.6.1, these five municipalities would affect approximately 3,700 more acres, in total, to accommodate housing for these additional residents.

The five corridor municipalities would experience a growth of 9,100 more jobs with the Build Alternative than with the No-Build Alternative. Manchester would experience the most employment growth with over 5,700 jobs and Windham would experience the least with nearly 500 more jobs. In terms of commercial and industrial development to accommodate this additional employment, between approximately 200 and 400 acres of land would be required in these five communities.

Based on a review of local master plans, zoning district maps and buildout analyses, if available, for each municipality, there appears to be sufficient available land area in most of the corridor municipalities to accommodate future growth. As an example, two I-93 corridor towns in New Hampshire have completed a recent inventory of available developable land, Londonderry has almost 7,200 acres and Derry has 6,100 acres, and future growth could involve nearly 4,400 acres in Londonderry and nearly 4,600 acres in Derry.

New Hampshire Non-Corridor Municipalities

In the remaining 18 municipalities in New Hampshire in the Study Area approximately 21,300 more residents would be added by 2020 with the Build Alternative than with the No-Build Alternative, according to the Panel's allocations. To accommodate this population, secondary residential development would involve approximately 13,700 more acres in total.

Approximately 6,600 more jobs would be added to these communities by 2020 with the Build Alternative than with the No-Build Alternative. To accommodate these new jobs in commercial, industrial and governmental developments the approximate amount of undeveloped land to be converted is between 100 and 300 acres in total.

Nashua Regional Planning Commission

Pelham is the only town within the Nashua Regional Planning Commission's service area that was included in the Study Area. While several communities within the Commission's area are adjacent to Study Area municipalities, the communities are less directly affected by I-93 as they are closer to US Route 3 and the F. E. Everett Turnpike.

Using the Panel's blended average allocations, Pelham would experience population growth of approximately 1,900 more people with the Build Alternative than with the No-Build Alternative. This population growth would involve approximately 1,300 more acres, in total, to accommodate housing for these additional residents.

The town would experience an increase of 370 more jobs with the Build Alternative than with the No-Build Alternative and would require between approximately 10 and 15 acres of land to be accommodated.

Rockingham Planning Commission

The Study Area towns within Rockingham Planning Commission areas are located in the southern tier of New Hampshire, or close to the State line.

The towns of Atkinson, Danville, Hampstead, Salem, Sandown and Windham would have approximately 6,600 more people in 2020 with the Build Alternative than with the No-Build Alternative, according to the Panel's blended average population allocations. To accommodate the population growth; approximately 2,900 more acres of land would be affected.

These six towns would have approximately 2,000 more jobs with the Build Alternative than with the No-Build Alternative, according to the allocations. High-density commercial/industrial development would require approximately 45 acres, in total, while low-density development would require approximately 81 acres, in total.

Southern New Hampshire Planning Commission

Auburn, Bedford, Candia, Chester, Derry, Deerfield, Goffstown, Hooksett, Londonderry, Manchester, and Raymond are within the service area of the Southern New Hampshire Planning Commission. In general, existing development is concentrated near the Merrimack River and such highways as I-93, US 3 and NH 101.

Approximately 21,600 more people would be added to these communities by 2020 with the Build Alternative than with the No-Build Alternative, or about two-thirds of the total population growth in the study area, according to the Panel's average blended allocations. Corresponding residential development in these towns would involve approximately 10,500 more acres of land.

The Master Plan update in 2001 for Bedford indicates that no new multi-family housing can be constructed and the residential land conversion considers this statement. Bedford is already nearing full buildout so conversion of additional land due to secondary impacts may become an issue in the future.

Approximately 10,800 more jobs would be added to these communities with the Build Alternative than with the No-Build Alternative, according to the Panel's allocations. The amount of undeveloped land that would be converted to accommodate the corresponding commercial and industrial growth in these towns is between 200 and 400 acres in total depending on the density of development. Bedford, Derry, Hooksett, Londonderry, and Manchester are more urbanized areas and have direct access to I-93, or I-293, which helps to explain why they are expected to experience the greatest amount of employment growth resulting in the relatively large amounts of land area required for commercial and industrial development in these towns.

Central New Hampshire Planning Commission

The Study Area municipalities of Allenstown, Bow, Concord, Dunbarton and Pembroke are in the Central New Hampshire Planning Commission service area. Approximately 5,200 more residents would be added to these communities by 2020 with the Build Alternative than with the No-Build Alternative, according to the Panel's allocations. Over half of this total would be in Concord. To accommodate this population, secondary residential development would involve approximately 2,700 more acres in total. Concord's residential growth is expected to be mostly in multi-family structures, requiring less land area than in Bow and Pembroke, for example, which would be mostly in single-family detached housing.

Approximately 2,400 more jobs would be added to these communities by 2020 with the Build Alternative than with the No-Build Alternative. Approximately 60 percent of these new jobs would be in Concord. To accommodate these new jobs in commercial, industrial and governmental developments the approximate amount of undeveloped land to be converted is between 50 and 100 acres in total.

Bow, Pembroke, and Concord have relatively direct access to I-93. Concord, the most urbanized municipality in this region, has approximately 6,600 acres of developable land available. The other less developed towns appear to have ample developable land available.

Other Areas Beyond Study Area

During the Expert Panel process two panelists included allocations for the towns of Boscawen, Canterbury and Loudon just north of Concord and the Study Area. The two panelists' blended average allocation anticipates secondary population growth of 500 people and secondary employment growth of 400 jobs in the three towns. These are modest increases even for these largely rural communities.

One panelist also mentioned three larger regions north of the Study Area; the Dartmouth/Lake Sunapee Region, the North Country and the Lakes Region, during meetings. This panelist was concerned about the impact of widening I-93 on secondary home growth. Secondary home growth is based on several factors including the state of the economy, in particular in the Boston, Massachusetts area and southern New Hampshire. In addition, other highways besides I-93 provide access to these regions, such as I-89 to the northwest and NH Route 16 in the east. The ease of access to an outlying region, also, in part, determines its attractiveness and consequent demand.

Land Conversion by Size of Municipality in New Hampshire

It is also useful to compare the secondary land use conversion by groups of similar sized municipalities in New Hampshire in terms of population, to better assess their relative ability to absorb both the growth allocated for the No-Build Alternative and the Build Alternative.

For the No-Build Alternative, using the panelists' blended average allocation, the thirteen municipalities in New Hampshire with populations of 10,000 people or less would experience a total population increase of approximately 27,800 people, requiring approximately 19,400 acres. Under the Build Alternative, the municipalities are expected to grow by another 10,800 people. This increase is estimated to result in the development of 8,200 more acres to accommodate this growth. These large amounts of land acreages directly correspond to large lot zoning in smaller, more rural communities.

For the five medium sized communities of between 10,000 and 20,000 people, a total population increase of approximately 25,100 persons is allocated under the No-Build Alternative, which will require roughly 16,000 acres. Under the Build Alternative these municipalities are expected to grow by another 9,100 people requiring 5,700 more acres to be accommodated. It appears that the relatively large amount of land to be affected is primarily due to the existing large lot zoning.

For the No-Build Alternative, using the panelists' blended average allocation, the five municipalities in the New Hampshire portion of the Study Area with populations above 20,000 are allocated a total population increase of approximately 48,500, which will require roughly 11,300 acres. Another 15,500 more people are expected in the Build Alternative, requiring 3,600 more acres. The amount of land required to accommodate this growth is considerably less than in the medium-sized and small-size towns, largely due to smaller lot size and higher density zoning in the larger communities.

By relating the amount of acreage to be affected to population size of municipality, it is clear that the larger communities have a higher density of development than the smaller communities. They accommodate the largest number of allocated people in the least amount of acreage. The larger municipalities have a larger percentage of multi-family dwelling units and smaller average lot size requirements for single family houses in their zoning ordinances. The smaller towns tend to be less dense and have larger minimum lot sizes for residences in their zoning, and less, if any, multi-family housing. The zoning codes, which are assumed to be unchanged in this analysis with regard to lot size specifications, form the basis of the calculations and the actual amount of land developed in each town may be less for reasons explained earlier.

A fact which is evident through the preceding discussion is that much of the growth in the Study Area is expected to occur regardless of whether I-93 is widened or not. Growth is expected to occur, even without the project, in response to other influences involving the overall quality of life conditions and continued economic prosperity found in New Hampshire. In addition, it is not clear whether the additional growth, and associated land conversion, under the Build Alternative is growth that otherwise would not occur, or growth that would simply occur later in time if the highway were not widened.

It should be noted that at least five communities in the Study Area appear to be reaching buildout and will have difficulty accommodating new growth as allocated by the Panel with or without the project, unless current zoning regulations are changed. Bedford, NH (population 18,000) has 5,700 acres of developable land, which would accommodate the No-Build allocations, but not the additional 1,900 acres with the Build Alternative. The larger Massachusetts communities of Lawrence, Methuen, North Andover and Tewksbury theoretically do not have enough developable land to accommodate the No-Build, let alone the Build allocations. This issue will be offset to some degree by infill development and conversion of existing sites and facilities to accommodate less space-intensive industries, or reuse of abandoned mill facilities. However, in general the issue does highlight the difficulty of predicting and evaluating future growth and associated land use.

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4.12.8 Potential Secondary Land Use Impacts on Environmental Resources

The potential land use impacts on environmental resources that could be attributed to secondary growth in the Study Area are discussed in this subsection. Land development and associated impacts depend on general regional and statewide economic conditions, state permitting requirements, local zoning and land use ordinances and their administration, and the decisions of individual landowners. Given these influences and changing conditions over time, it is difficult to forecast with real confidence specific areas that may be developed or not, and the impacts of such development, under the No-Build and Build Alternatives. As a result, the ensuing discussion addresses secondary land use impacts on environmental resources qualitatively.

New Hampshire Municipalities with Developable Land Inventories

Five of the six New Hampshire municipalities in the Study Area, for which the amounts of remaining developable land were available in their master plans, or other studies, appear able to accommodate No-Build growth as well as Build (secondary land use) growth (Table 4.12-8). The one exception is Bedford. As these estimates of developable acres have assumed that development in areas with sensitive environmental features would not occur, the direct impacts of growth should not adversely affect these resources. The municipalities of Auburn, Chester, Deerfield, Derry and Londonderry appear to have enough land to accommodate allocated growth. Londonderry and Derry are both towns in the I-93 project corridor. Of the five municipalities in the project corridor, these two would require the conversion of the most acreage for allocated secondary population growth associated with the Build Alternative.

Regarding the case of Bedford, its master plan indicates that there are 5,700 acres of developable land remaining, which excludes sensitive environmental resource acreage. Approximately the same amount of land (5,698 acres) would be converted to residential development, based on the Expert Panel's population allocation for the Town under the No-Build Alternative. In other words, the town would be fully built out by 2020 even without the widening of I-93, with no expected impact on environmental resources. With the project (i.e., the Build Alternative) approximately 1,900 more acres would be required to accommodate the additional residential growth. Theoretically, it would not be possible to accommodate this additional growth given the town's current zoning. Further, this additional growth, if it were to occur without some change in current zoning regulation, would be expected to have impacts on environmental resources. These growth allocations reflect Bedford's strategic geographic location in a fast growing sector of the Manchester metropolitan area, and its easy access to many key highways and the Manchester Airport. With such growth potential, Bedford would have to modify its current zoning ordinance

Table 4.12-8
Natural Resources by Community in the Study Area (in Acres)

Town	Total Town Area	Conservation Lands[1]	NWI[2]	Unfragmented Tracts > 500 Acres[3]	Farm Land[4]	Developable Land Available[5]	Unprotected Priority Open Space[6]
Allenstown	13,167	6,761	898	11,540	239		-
Andover, MA	20,583					4,743	-
Atkinson	7,258	663	590	2,629	477		470
Auburn	18,438	4,206	3,687	12,663	436	8,652	6,010
Bedford	21,156	768	1,422	5,860	1,656	5,700	-
Bow	18,269	1,846	1,739	10,310	737		-
Candia	19,557	1,642	1,588	15,376	279		4,200
Chester	16,718	1,312	1,460	14,284	840		3,940
Concord	43,000	7,458	5,112	21,998	4,295	6,664	-
Danville	7,569	454	1,277	5,199	168		900
Deerfield	33,348	5,063	3,116	29,518	842	15,521	3,790
Derry	23,226	1,013	2,390	6,919	1,315	6,100	460
Dracut, MA	13,699					4,987	-
Dunbarton	20,046	4,122	2,169	18,334	1,139		-
Goffstown	24,065	1,765	1,300	15,131	1,852		-
Hampstead	9,014	1,389	1,464	2,485	374		420
Hooksett	23,761	2,963	2,095	15,744	684		2,380
Lawrence, MA	4,753					211	-
Londonderry	26,958	1,229	2,716	9,747	1,651	7,185	2,700
Manchester	22,355	1,269	2,234	3,067	807		1,640
Methuen, MA	14,722					2,425	-
North Andover, MA	17,706					3,188	-
Pelham	17,151	1,092	2,334	8,061	933		240
Pembroke	14,597	342	544	10,243	1,400		-
Raymond	18,943	871	2,437	10,709	212		2,410
Salem	16,569	642	2,553	2,575	551		0
Sandown	9,232	284	1,353	5,855	213		740
Tewksbury, MA	13,526					1,712	-
Windham	17,772	641	1,968	8,935	612		1,060
Total	527,158	47,795	46,453	247,170	21,710		

1 Conservation Lands excluding outlots. Source: New Hampshire Resource Protection Project, I-93 Corridor Wildlife Habitat Study; Audubon Society of New Hampshire/UNH Complex Systems Research Center
2 Total National Wetland Inventory features. Source: USGS/GRANIT
3 Unfragmented Tracts of Land greater than 500 Acres – some areas may be contiguous with NWI features and Conservation Lands. Source: New Hampshire Resource Protection Project, I-93 Corridor Wildlife Habitat Study.
4 Agricultural land use acreage. Source: 2001 Land Cover Assessment, GRANIT
5 As identified in the municipal master plan or build out scenario
6 Priority open space areas not within conservation lands or not surface waters. Source: New Hampshire Resource Protection Project, I-93 Corridor Wildlife Habitat Study

(and its Master Plan) to allow for development in sensitive resource areas and/or accommodate denser development, or conceivably if Bedford retains its current zoning, this growth potential may be diverted to other nearby communities.

In contrast to Bedford, Auburn would be able to accommodate all the allocated growth, with or without the project. Auburn has nearly 8,700 acres of remaining developable land. Total growth (No-Build plus Build for both residential and employment growth) would involve approximately 3,500 acres. As in Bedford, the Auburn developable land amount excludes environmental resources and constraints. However, indications are that Auburn (in spite of its proximity to Manchester and its access to NH101 and ultimately to I-93) can experience substantial growth, but do so without changing its current zoning ordinances, and without affecting sensitive environmental resources.

In Deerfield, nearly 16,000 acres of developable land is available, according to its master plan. In contrast, 2,000 acres would be affected by future growth assuming the highway is widened. Accordingly, this town has ample land available to accommodate this growth, with no undue impacts on sensitive environmental resources. Deerfield is located in the northeast portion of the Study Area and is among the more rural towns in the Study Area.

On the other hand, Atkinson with a total land area of approximately 7,260 acres and an existing population of 6,000 people is expected to see its population increase to approximately 9,000 people affecting an additional 2,500 acres. There are no available estimates of available developable land in Atkinson, but given the limited size and relatively large increase in population and land use, its ability to accommodate such increases may be problematic.

Municipalities without Developable Land Inventories

As highlighted in the discussion above concerning Atkinson, it is difficult at best to draw conclusions relative to what degree future growth will adversely affect environmental resources without some type of estimate of acreage of developable land. Environmental resources in rural municipalities with large land areas and relatively modest growth are less likely to be adversely affected. Those communities with smaller land areas and more substantial growth may experience more development pressure that could result in more substantial impacts to natural resources. There is no available accepted ratio or correlation between developed acres and acres of affected natural resources (e.g., wetlands). Development on a specific site is typically dependent on site specific resources, terrain and conditions, and generalizations as to what acreage of natural resource impacts might be expected per acreage of development are speculative. For instance, there are no studies prepared by the American Planning Association or the Urban Land Institute that have determined such a correlation.

The land use plans and zoning information for each municipality in New Hampshire were consulted at the OSP to understand where future development is officially expected or desired to occur. It is assumed for this study that all growth will occur within these planned future development areas in a manner generally consistent with these adopted plans. A review of these plans and information indicates that many, if not most, towns have enough land to accommodate future growth under the Build and No-Build Alternatives, particularly in the less populated, more rural communities.

An additional source of information relative to important natural resource areas in the New Hampshire segment of the Secondary Land Use Impacts Study Area, includes GIS data from a co-occurrence study covering a large segment of southern New Hampshire. This co-occurrence study is independent from the work done for this EIS. The co-occurrence study was conducted by the Complex Systems Research Center of the University of New Hampshire and the Audubon Society of New Hampshire for the U.S Environmental Protection Agency. The resources considered in the co-occurrence study include: wildlife habitat areas, reptile and amphibian reporting program areas, conservation lands, large wetlands, vernal pools, surface water, unfragmented tracts, and The Nature Conservancy (TNC) portfolio features. A review of these data from the co-occurrence study showed that within the Secondary Land Use Study Area, these environmental resources are widespread and some of these resources function in combination (i.e., co-occur) as integral parts of larger environmental systems. Table 4.12-8 shows the acreage of the more important co-occurrence areas that are in the Study Area that may be subject to development pressures in the future.

The data in the co-occurrence study were not prepared to provide detailed impact analysis associated with future growth in New Hampshire. However, the data can be used to gauge the difficulty future growth may pose for the most valuable resource areas based on the communities' land areas, magnitude of future growth, and acreage of future land use. The maps created as part of the co-occurrence study are intended to help communities identify and become more aware of environmentally sensitive lands within their jurisdictions.

After mapping the known natural features to identify a first set of environmentally sensitive areas, and noting the degree of co-occurrence between various natural resources, the sponsors of the co-occurrence study invited natural resource experts from various natural resource agencies and organizations to identify a second set of areas that were most important to preserve from future development. In addition, conservation commissions from the 14 towns that the sponsors of the co-occurrence study anticipated will experience large amounts of growth from the I-93 project selected a third set of areas.

The co-occurrence study sponsors then overlaid these three layers and 23 sites were identified as "priority" open spaces in the I-93 Secondary Land Use Impacts Study Area. These sites are those that overlapped at least two of the three sets of areas

outlined above. The last column in Table 4.12-8 shows the acreage of these more important co-occurrence areas that are located on private property and may be potentially subject to some development pressure over time.

In considering municipalities without a developable land inventory, for this EIS, it is assumed that future growth will avoid the surface water features and National Wetland Inventory (NWI) wetlands. When these water resource areas are removed from consideration, enough acres of land appear to remain in most New Hampshire communities, to accommodate future development, according to the master plans. These resources exist throughout the Study Area and are located in no regular pattern. Some of these surface water features are also public water supplies, such as Massabesic Lake, Canobie Lake, and Arlington Mill Reservoir. Conservation and public lands already surround most of Massabesic Lake to protect its water quality. In fact, the protection of this resource has greatly affected the development pattern of Auburn, especially, according to the town's master plan, as development is channeled away from this resource. In general, it would be expected that these water resources would be protected from future development by existing wetland and stream protection regulations.

However, several of the master plans mention that the shores of lakes and ponds in the municipalities were originally developed for recreation use during the summer. As a result, development in many towns tends to actually be higher around these large surface waters. Due to increased housing demand in municipalities, many of these seasonal homes have been converted for year round use though their septic systems have not been upgraded for the increased use. The town plans of Windham and Salem, for instance, both mention this fact.

Conservation lands are those where development is either prohibited or closely monitored. These areas are located in most of the communities in the Study Area in no particular pattern, but are generally near or include important water resources. The amount of conservation lands range from a low of just over 2 percent in Pembroke to a high of 52 percent in Allenstown. The high number for Allenstown is explained by the presence of Bear Brook State Park. Conservation lands would be expected to be protected from future growth due to existing regulations.

Unfragmented tracts of land greater than 500 acres in size are generally more prevalent in the northern, less developed, communities of the Study Area than in the southern more developed communities of the Study Area. Further, large contiguous areas of unfragmented tracts tend to be farther away from I-93 and the Merrimack River. These unfragmented tracts constitute good habitat for wildlife. The proportion of unfragmented tracts to total town size in acres range from a low of approximately 14 percent in Manchester to a high of approximately 91 percent in Dunbarton.

These large tracts are in communities where there may be a greater percentage growth in population, but smaller growth in terms of absolute numbers. Given the rural nature of these towns and large amounts of undeveloped land, their ability to

absorb projected increases in additional population is good, however such growth may incrementally reduce the size of individual unfragmented tracts. If development occurs in scattered locations, the impacts on this resource will be greater than if development occurs in clusters. Because large tracts of privately owned unfragmented land are not restricted by permitting requirements from being developed, it would be expected that some future development will take place on these lands, adversely affecting, to some degree, the benefits such unfragmented lands contain.

Farmlands can experience increasing pressure to convert to residential use as the Study Area municipalities become more developed. Using land use data derived from the 2001 Land Cover Assessment produced by GRANIT (The State of New Hampshire's GIS system), the percentage of farm acres to total acres in a town in the Study Area range from approximately 1 percent in Raymond to 10 percent in Concord. In keeping with the general development pattern of the Study Area, higher concentrations of farmland are located in the north and farther away from I-93 and the Merrimack River, much like the unfragmented tracts. In addition, like the unfragmented tracts it would be expected that future growth will result in the loss of some farmland, reducing the quantity of this resource.

Lastly, another piece of information of interest is the fact that the NHDES keeps records of the acreage of wetlands impacts throughout New Hampshire in a year. Based on the criteria used to define wetland related impacts, approximately 150 acres of wetlands are currently affected per year, statewide, for all projects (public and private) taking place. Over a five-year period (1997 through 2001) NHDES records show that approximately 550 acres of wetland were lost, but that over 160 acres of wetlands were created or enhanced and 3,600 acres of upland and wetlands were protected under conservation easements or deed restrictions. While the widening of I-93 may accelerate or increase growth in New Hampshire to some degree, the additional impacts to wetlands would not appear to substantially change the magnitude of impacts that historically have occurred.

The U.S. Army Corps of Engineers keeps similar records from which, based on their criteria, data indicates that approximately 80 acres of wetlands are affected throughout the entire state per year. Further, these data indicate that the affected wetland acreage per year is decreasing over time, as developments become more sensitive to environmental considerations.

In general, future growth and associated land use impacts are expected to occur in areas planned by localities for future development, which are areas that do not necessarily contain valuable natural resources. Accordingly, future land use development (including that induced by the widening of I-93) cannot be assumed to take place in areas of important natural resources, such as those mapped in the co-occurrence study. The most vulnerable of these resources, such as wetlands and vernal pools, are protected by regulation, as are conservation lands. Further, there appears to be sufficient land to accommodate the land conversions computed for the

No-Build and Build Alternatives in most of the communities in the New Hampshire segment of the Study Area. Large unfragmented tracts of land and farmland, however, are not necessarily protected in the Study Area. Though any new development may encroach on these lands, such development is expected to be in keeping with local planning in accordance with local priorities.

Massachusetts Municipalities

In the Massachusetts segment of the Study Area, mapping of environmental resources was done as part of the buildout scenarios performed for each municipality. These resources were excluded from the developable land acreage in each. Wetland resources are located in all six municipalities and include the Merrimack River. The major surface water resources are Lake Cochichewick in northeast North Andover, Haggetts Pond in west Andover and scattered wetlands in southeast Andover and west Methuen. The largest tracts of conservation lands and unfragmented forests are in the southern sections of the adjacent towns of North Andover and Andover.

Future residential land use development, in these communities, is presumed to be in the nature of "infill", i.e., within largely already developed and appropriately zoned areas, since there are few large tracts of land areas that remain for substantive future development. Lawrence, the largest city, is virtually fully built out. While there are large tracts in northern Methuen, they are zoned for Agricultural/Conservation. In southern North Andover, a large undeveloped area is predominantly a 100-year flood zone. Based on the residential zoning district patterns, it appears that the important environmental resources are largely protected from future residential development impacts.

Future industrial and commercial development is expected to be located on land appropriately zoned for such uses. These areas are located near I-93 and I-495 and other major State highways. While some industrially zoned land is located near the Merrimack River (for instance in North Andover), environmental resources in these municipalities appear to be protected from future land use impacts as the locations of industrially zoned land in relation to the location of the mapped resources are appropriately planned.

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4.12.9 Mitigation/Enhancement

Neither the Council on Environmental Quality (CEQ) regulations nor FHWA's environmental guidance documents implementing NEPA requires mitigation of secondary land use impacts associated with highway improvement projects. Specifically, the CEQ regulations are silent regarding the issue of mitigation for secondary impacts. FHWA policy as governed by 23 CFR 771.105, discusses mitigation in section (d)(1) and (2) for adverse impacts that actually result from a project and that the mitigation represents a reasonable public expenditure. The

regulation does not specifically address mitigation for secondary impacts. In addition, the permitting requirements associated with Section 404(b)(1) guidelines governing the U.S. Army Corps of Engineers' permit are limited to requiring mitigation for secondary impacts that are quite specific and predictable relative to location and degree. More generalized secondary impacts like those associated with possible future growth in a region do not require mitigation. Further, there is little precedent nationwide where a State DOT has specifically mitigated secondary impacts for a proposed project. Instead, such potential impacts are identified, evaluated, and documented in relation to all other impacts so decision-makers have pertinent information on hand to make appropriate judgments. This type of comprehensive evaluation of the full range of impacts to environmental, cultural, social, and economic resources is required under NEPA before State Highway Agencies, the FHWA and permitting agencies can make project decisions. Consideration of secondary land use impacts is one area under consideration in this process.

As previously stated, the secondary impacts associated with widening I-93 are difficult to predict and catalogue with any certainty or specificity. In addition, it is not clear whether the additional growth, and associated land conversion, under the Build Alternative is growth that otherwise would not occur, or growth that would simply occur later in time if the highway were not widened. The evaluation process involves designating a study area (that is, the area subject to the project's influence); forecasting potential growth in population and employment, based on two alternatives (No-Build and Build); interpreting how this growth will translate into potential future land use; and lastly, predicting how the potential future land use may affect natural resources. Due to the overall uncertainties (largely because of the complexities involved, but also in part because of the lack of good historical data), the results of the study of secondary impacts are more informational than something for which specific areas or resources can be designated as requiring mitigation.

Community Technical Assistance Program

Development issues have traditionally been addressed by the municipalities through the administration of land use regulations (zoning, site plan, and subdivision regulations) usually based on local master plans. In recognition of this, an initiative is proposed as an enhancement of this project, which supplements the local approach by making available technical assistance to help communities in the area influenced by this section of I-93 better deal with and manage growth and development pressures.

The Community Technical Assistance Program is envisioned as a joint effort of state agencies and private organizations to help communities better manage growth and advance conservation efforts. The program is intended to assist the five "primary" communities of Salem, Windham, Derry, Londonderry, and Manchester and the twenty-one additional "secondary" communities (**Figure 4.12-1**). The program will be initiated as a NHDOT-led project with initial funding of $3.5 million in Federal

and State transportation funds to be provided over approximately five years as part of the overall I-93 improvements between Salem and Manchester. Additional support is expected to be provided in terms of staff time from participating organizations and solicitations for additional Federal, State, local and private funding. The goal is to establish a self-perpetuating program to provide coordinated support to local communities that continues beyond the initial five-year period.

An NHDOT/NHDES committee including representatives of the OSP, and the four involved regional planning commission's (Nashua, Rockingham, Southern New Hampshire and Central) has met periodically in 2003 to begin organizing the program. It is envisioned that the Community Technical Assistance Program will provide the following types of tools and services:

- Direct technical assistance to communities to support planning and conservation,
- Funding for innovative projects proposed by communities,
- Training and education for professionals and local officials,
- A marketing campaign to raise public awareness and acceptance of smart growth concepts,
- Analyses of alternative future growth scenarios, and
- Development of specific tools and materials to support local planning and conservation efforts.

Details of several of these areas are being explored in a number of subcommittees representing broader interest groups. The details of the program are still evolving and will not be finalized until after the member communities have had a chance for input.

In terms of organizational structure, it is hoped to have input from: a community committee – representing each of the member communities and providing opportunity for a more regional approach to growth issues; an agency committee - representing regional planning commissions and State and Federal agencies; and an advisory committee – representing a wide variety of statewide interests ensuring that broader statewide smart growth principles are adapted and applied at a regional level as well. A steering committee, comprised of representatives of each of the committees will provide overall direction and consensus driven decision-making regarding the final make-up and implementation of the program. NHDOT in conjunction with the other agencies, groups and interested parties will continue to refine the scope of work, services, and organizational structure for implementation of this program.

This assistance is complementary and builds on the efforts of two other initiatives: the Governor's Initiative on Sprawl and the Grow Smart New Hampshire effort. The Governor's Initiative was administered by the OSP and has involved a wide range of federal, State and regional agencies as well as business interests and advocacy groups. The initial work included a report on sprawl in New Hampshire – a general historical perspective as well as a detailed look at three areas of the State. The report included general goals and objectives for growth as well as recommendations for programs and legislation to assist communities to better assimilate future growth and development. The Grow Smart New Hampshire program is an offshoot of the Governor's Initiative on Sprawl. The OSP, NHDES and NHDOT, in conjunction with the USEPA, have coordinated resources and funded the program. The program selected three communities within the area influenced by the widening of I-93, and proposes to identify steps each might take to handle future growth effectively. In addition, a reference manual entitled Achieving Smart Growth in New Hampshire was prepared containing a series of Smart Growth principles, supplemented with local examples and references as a resource by all communities. This report was supplemented by a series of regional awareness meetings and an Achieving Smart Growth in NH Website to serve as a continuing resource. To a degree, this program serves as a precursor to the Community Technical Assistance Program proposed in raising awareness and education of Smart Growth Principles.

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4.12.10 Conclusions

Given the complexities of land use, transportation, economics and environmental regulation, it is not possible to attribute and predict with certainty the secondary land use impacts associated with improvements to an existing transportation infrastructure. Improvements to existing infrastructure do to some degree enhance the economic climate for subsequent development, but whether over time the secondary growth would have occurred regardless of the infrastructure improvements is not known. Beyond this basic question of whether secondary impacts will occur, the questions of degree and location are equally difficult to answer.

This analysis attempts to provide some insight as to what the future might hold. In doing so, it attempts to provide local officials, planners, and public citizens an estimate of the existing situation and the possible future situation relative to potential development activity that might be fostered, in part, by the widening of I-93 from Salem to Manchester. Using the Expert Panel and a variation of the Delphi process, it appears that widening I-93 would induce some additional growth beyond what might be expected by 2020 if the highway were not widened. Using the Panel's blended average allocations for this Study Area, the additional growth in total may be in the range of 5 percent. Within New Hampshire, the Study Area communities may experience an additional growth in population of over 35,000 people and in employment of nearly 16,000 jobs by 2020 because of the widening of I-93. Through the use of this information, stakeholders can be better informed as to the magnitude of growth and how to adapt their local ordinances and zoning codes to accommodate

future growth. The GrowSmart New Hampshire initiative has developed information to assist communities on how they might manage growth. In addition, Statewide GIS mapping projects such as the aforementioned Co-occurrence study, provide information relative to areas within communities that need to be protected given their high degree of natural resource value. Additional assistance in the form of a Community Technical Assistance Program would expand upon these initial efforts to provide ideas and tools so communities might better accommodate and direct growth that is coming regardless of the final composition of I-93.

4.13 Petroleum & Hazardous Materials and Solid Waste

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4.13.1 Impact Methodology

An impact related to a petroleum, hazardous material release site, solid waste site or building demolition is determined to exist if a selected alternative has the potential to encounter contamination or building demolition is required. When an impact is identified, specific procedures may be implemented to define the nature and extent of that impact as it relates to the specified alternative. In general, an identified impact for a potential release site or potential building demolition does not necessarily indicate that a certain alternative is less desirable. Contaminated properties or building demolition can usually be managed efficiently and cost effectively during construction.

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4.13.2 Potential Project Impacts and Mitigation

4.13.2.1 Potential Petroleum, Hazardous Material Release Sites and Solid Waste Sites

Initial Site Assessment (ISAs) were performed for certain properties that could pose a risk to encountering contamination that may impact a selected alterative. An ISA represents the first step in an iterative process to determine if a property could be contaminated. Typical findings of an ISA identify historic releases that have already been documented and potential sources areas that could contribute to contamination (i.e., underground tanks, floor drains, fill areas). Following completion of the ISA and if determined to be warranted, the next step would be to perform Preliminary Site Investigations (PSIs). PSIs included subsurface investigations to determine the nature and extent of any suspect contamination. Subsurface investigation typically included the excavation of test pits, drilling of soil borings, and the installation of groundwater monitoring wells. Soil and groundwater samples collected during the PSI are

analyzed by a laboratory to determine if contaminant levels require remediation in accordance with DES regulations.

The following Table 4.13-1 summarizes the 13 properties that could impact an alternative related to petroleum or hazardous material releases or solid waste sites. The properties were selected based on the findings of the ISA's, supplemental field reconnaissance, and current property usage.

Table 4.13-1
Summary of Potential Petroleum & Hazardous Material, and Solid Waste Sites That May Impact an Alternative

NHDOT Parcel ID	City	Street	Former/Existing Use	Proposed Impact	Alternatives Impacted	Figure 3.12-1 Map ID
S226	Salem	Cross Street	Town Maintenance Facility	Limited land tanking along north and westerly property boundaries.	All	4
S73	Salem	Keewaydin Drive	Potential Asbestos Disposal Site	Partial taking for proposed detention basin and widening.	All	83
S74	Salem	Keewaydin Drive	Former Manufacturing	Partial land taking for proposed detention basin and widening.	All	14
S173	Salem	Raymond Avenue	Existing automotive maintenance	Full land taking for proposed park-and-ride.	All	81
W106	Windham	Range Road	Former maintenance garages.	Full land taking.	Options 7, 8, 9	77
W99	Windham	Route 111	Existing gasoline station	Full land taking.	All	29
W44	Windham	Route 111	Existing gasoline station	Full land taking.	Options 3, 4, 5, 6, 8, and 9	31
W35	Windham	Route 111	Existing automotive activities	Full land taking.	Options 3 to 6, 8, and 9	82
D25	Derry	Kendall Pond Road	Maintenance facility	Partial land taking along northeastern property boundary for proposed detention basin.	All	80

Table 4.13-1 (continued)

NHDOT Parcel ID	City	Street	Former/Existing Use	Proposed Impact	Alternatives Impacted	Figure 3.12-1 Map ID
L174	Londonderry	Londonderry Road	Automotive maintenance and transmission repair	Full land taking.	All	76
L130	Londonderry	Route 28	Existing gasoline station	Full land taking.	Relocated NB ramps and Relocate NH 28	66
				Partial land taking.	All	
L81	Londonderry	Rockingham Road	Existing gasoline station	Full land taking	Park-and-ride option	67
				Limited frontage land taking	All	
L82	Londonderry	Rockingham Road	Former solid waste landfill and existing transfer station	Partial land taking.	Park-and-ride option.	52

The above list of properties represent the properties that have a probability of encountering contamination that may affect an alternative. ISAs have been completed for several of the above properties (see Table 3.12-2). The steps that will likely occur to further evaluate the above properties includes the following:

- Perform ISAs for the remaining properties that are included within a Selected Alternative.
- Based on the ISA results, perform PSIs. The properties that are currently being monitored for contamination (Groundwater Management Permits or GMPs) may require further sampling and analysis but will likely not likely require a full PSA.

In addition to these site listed above, the proposed wetland mitigation sites will be evaluated. Based on these preliminary evaluations, complete ISAs may be performed for certain mitigation sites.

Based on the results of the PSIs, contamination may be identified. In the event contamination is identified, the following scenarios are likely:

- Contamination is limited to groundwater that does not warrant remediation and the groundwater will not be encountered during construction.
- Contamination is limited to soil that does not warrant remediation and the contaminated soil will not be encountered during construction.

- The contaminated soil or groundwater identified requires remediation by NHDOT following property acquisition.

- The contaminated groundwater identified will not be encountered during construction and assessment/remediation is ongoing by the existing property owner as part of an existing Groundwater Management Zone (GMZ) permit.

- Limits of solid waste will be categorized. Removal, or consolidation of solid waste on-site will be performed in consultation with NHDES.

- If contaminated materials are expected to be encountered during construction, appropriate worker health and safety provisions and waste management provisions will be identified. Provisions may include health and safety plans (HASPs) and soil/groundwater management plans for excavation and on/off-site management of waste materials. All work will be performed in accordance with applicable NHDES regulations and NHDES approved remedial action plans.

4.13.2.2 Building Demolition

Prior to any schedule building demolition, a comprehensive building audit will be performed to identify and quantify all regulated building materials and special wastes. Building that may require demolition are summarized in Table 3.12-3. Materials and wastes that may be inventoried include the following:

- Asbestos
- Lead-based paint
- Polychlorinated biphenyls (PCBs) within fluorescent light ballasts
- Electrical transformers that may contain PCB dielectric oil
- Mercury-containing fluorescent light bulbs
- Mercy thermostats
- Miscellaneous containers of oil or hazardous materials
- Refrigerants (air conditions, refrigerators)
- Hydraulic lifts
- Aboveground storage tanks
- Underground storage tanks

The scope of each audit will vary based on building type, age, and current use. Residential buildings will likely be limited to asbestos and lead paint audits, while commercial buildings will include a more comprehensive audit for other regulated materials. Based on the findings of the building audits, abatement plans will be prepared to address the removal of all regulated building materials, including asbestos and lead paint.

Other miscellaneous containers of oil and hazardous materials will also be removed prior to demolition. These materials will not be commingled with the general building demolition waste stream. Tank closure assessments will be performed

following the removal of every underground storage tank. The assessments will determine if contamination is present and whether remediation is required.

4.14 Energy Impacts

Energy to perform construction, in the form of diesel and gasoline fuels, will be required with the Build Alternatives, which involve extensive cuts and fills, including bridges, on new location. The No-Build Alternative would not involve the use of such energy per se, although the condition of the existing infrastructure is poor, and continued maintenance will require more intensive energy dependent work efforts over time.

Since the project will improve the flow of traffic through the corridor, future vehicular energy requirements will be less due to more efficient traffic flow along the highway. Conversely, energy requirements will be higher with the No-Build Alternative because of less efficient traffic flow.

The project with the addition of extra lanes will require additional expenditures of energy as compared to today for maintenance activities. These activities include plowing, sanding, mowing, bridge and drainage system maintenance, and roadway surface repairs. However, because the new roadway surface will be built to improved standards, which incorporate the latest technology and materials, the facility will require less maintenance in the future.

4.15. Construction Impacts

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4.15.1 Effects

Impacts caused by construction activities will occur with any of the alternatives except No-Build. Construction impacts will be short-term, however, and would vary little among the Build Alternatives. Construction activities may result in temporary adverse impacts, with the two primary pollutant sources during construction being construction equipment and exposed soils in unvegetated areas.

Air pollutants emitted from diesel and gasoline powered construction equipment will include oxides of nitrogen, carbon monoxide, hydrocarbons, and particulate matter. Emissions from construction equipment may result in elevated ambient concentrations within the immediate vicinity of construction operations for short periods of time, but are not expected to have a substantial impact.

Particulate matter (dust) will be emitted as a result of grubbing, grading, excavating, hauling, and blasting operations. Dust emitted during most construction activities

will be controlled by wetting unpaved areas in the construction zone, covering loads on all open trucks, and seeding all unvegetated areas as soon as practicable. These methods will be employed during construction of any of the alternatives.

Activities associated with construction will likely require blasting of bedrock material in some areas and extensive grading. The grading will include the stripping of existing vegetation, followed by major excavation and filling. This construction will result in nearly complete reworking and/or removal of surficial and subsoils along the sides of highway. Exposure of previously vegetated soils could lead to erosion if not properly controlled.

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4.15.2 Mitigation

To mitigate potential sedimentation impacts by construction, a well-defined drainage and erosion control program, including BMPs, will be developed and implemented. Construction schedules will require that areas stripped of vegetation be limited in size and either surfaced or vegetated as quickly as possible after initial exposure. During the construction period, temporary erosion check dams will be installed in appropriate locations. With proper diversions of flow, installation of silt retention basins, and construction carefully scheduled to limit soil exposure, erosion during construction should be minimized. BMPs for fertilizer application during construction will also be followed. In addition, mechanisms to avoid and control chemical leaks and spills from construction equipment will be instituted. NHDOT will ensure that all of these measures are properly installed and maintained throughout construction to ensure their maximum functionality and effectiveness. Additional details can be found in *NHDOT's Standard Specifications for Road and Bridge Construction, Section 699, Temporary Project Water Pollution Control (Soil Erosion)*.

Removal of streambank vegetation during construction can impact stream ecosystems. Overhanging vegetation provides a major food source for benthic communities (Minshall 1967), overhead cover for fish, shade, and a buffer to sedimentation. Removal of riparian vegetation could intensify daily water temperature fluctuations and potentially change the benthic macroinvertebrate community composition from leaf litter consumers to algal consumers. Maintaining a buffer strip of vegetation near streams will avoid these impacts. Streamside areas cleared of vegetation will be revegetated as quickly as possible.

Highway construction will unavoidably destroy habitat important to wildlife and thus may kill some animals and displace others. Some fossorial animals and breeding animals and their young will most likely to be lost during construction. More mobile animals will move to other habitats. NHDOT in cooperation with NHF&GD will also educate construction personnel on how to identify hognose snakes and the means to avoid any impacts on this species.

Human presence and associated construction noise at new location areas may repel some species of wildlife from the edge of the right-of-way. Animals tend to habituate to constant noise (Busnel 1978), but loud, sudden sounds will be commonplace during construction. The loud noises associated with construction also could mask territorial vocalizations of bird species near the construction, interfering at least temporarily with breeding. Amphibians, which breed more commonly at dusk or night, are less likely to be indirectly affected by the noise.

Construction activities will result in substantial, but temporary, noise impacts to sensitive receptors at various locations along the project's length. Noise levels in the vicinity of construction activities will vary widely depending on the type and number of pieces of construction equipment active at any one time (Table 4.8-3).

It is expected that noise levels exceeding 67 decibels could occur up to 500 feet away from construction activities. Construction noise will, in some areas, be occurring near residences presently experiencing lower noise levels. Where possible, proposed sound walls will be constructed prior to reconstructing and widening the highway. In general, construction will be accomplished during daylight hours, although night-time construction should be expected given the traffic volumes during daylight hours and the need to maintain traffic at these times.

Construction will create increased truck traffic on secondary roads. Access to I-93 will be maintained although unavoidable delays will occur. Temporary delays will be experienced getting on and off I-93 and along the mainline as bridges are worked on, traffic is shifted temporarily from one side to the other, equipment is moved around, and materials delivered. NHDOT will continue to coordinate with local and state emergency response personnel to develop efficient incident management procedures and protocols. ITS technologies will be deployed to more efficiently manage traffic, enhance incident management during construction, and provide real-time traveler information. A detailed Traffic Control Plan, to include incident management procedures, will be instituted to reduce traffic-related, short-term impacts and minimize construction zone delays. The plan will include the requirement to maintain 2 lanes of traffic in both directions along the mainline for normal construction activities, and during high volume traffic periods. Businesses and their customers may experience some inconvenience due primarily to construction activities along their frontage on secondary highways in interchange areas. Construction activities will be coordinated with property owners to assure that reasonable access to properties is maintained. Temporary signing and other issues related to temporary relocation of access points, caused by construction activities, will be appropriately addressed on an individual basis.

Some short-term visual impacts will also occur during construction as land clearing and earth-moving occurs. Additionally, some views will also be disrupted by the presence of temporary construction or access roads that may be needed.

4.16 Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

Current congestion along the I-93 corridor impedes travel through the corridor, both north and south, as well as traffic accessing or traveling through the various interchanges. Transportation improvements, like the proposed one, are based upon a comprehensive planning process by the NHDOT. This planning considers the need for present and future transportation needs within the context of present and anticipated future land-use development. Local short-term impacts and use of resources by the project are thus determined to be consistent with the maintenance and enhancement of long-term productivity for the State as a whole before a highway project is approved.

The types of impacts for all the Build Alternatives in the project corridor would be similar. Most short-term impacts will be associated with construction: noise, temporary impacts to air quality, disturbance of soils, potential sedimentation (temporarily reducing water quality and affecting aquatic communities), potential traffic delays, and temporary visual impacts. Erosion and sedimentation will be minimized during construction through the use of Best Management Practices (BMPs) to avoid impacts to aquatic communities. Other impacts would cease after construction. In comparison, short-term benefits of construction will include additional employment and an additional source of revenue to the local service industry. Increased local spending during construction would also benefit the economy of the communities in the corridor.

Socio-economic impacts will include some loss of residences, businesses, and agricultural land; possible changes in the value of residences affected by the highway widening and other modifications to the infrastructure; and some loss of tax revenue due to right-of-way (ROW) acquisitions necessary for the widening, the realignment of some cross roads, and for interchange modifications. Some of the necessary ROW acquisition may impact land planned for future development, both residential and commercial. These economic impacts will be compensated for in the long term, however, by improved access within the region. Loss of residences and businesses will impact communities, but the impacts can be absorbed because there are adequate residential and commercial properties for sale or lease in the project corridor to accommodate those displaced. The fiscal impacts to the towns and the economic impacts caused by direct displacements and the loss of property for transportation needs may in the near term be difficult, but over time the redevelopment potential would appear to exceed the immediate losses in terms of value.

With regards to long-term impacts on natural resources, the loss of some forest and natural land will incrementally reduce the rural ambience and appeal of the area. The permanent loss of wildlife habitat will also result in some reduction in the animal

populations currently living within the project corridor. However, this latter effect will be offset by the habitats created in the wetland mitigation areas as well as by the permanent protection of habitats in areas purchased for preservation purposes. The potential loss of historic structures is less easily mitigated and typically represents more permanent losses in terms of from the cultural environment.

4.17 Irreversible and Irretrievable Resource Commitment

Implementation of the project will involve a commitment of a range of natural, physical, human, and fiscal resources. Land used in the construction of the proposed facility is considered an irreversible commitment during the time period that the land is used for a highway facility. However, if a greater need arises in the future for use of the land or if the highway facility is no longer needed, the land can be converted to another use. At present, there is no reason to believe such a conversion will ever be necessary or desirable.

Considerable amounts of fossil fuels, labor, and highway construction materials such as cement, aggregate, and bituminous material will be expended. Additionally, large amounts of labor and natural resources will be used in the fabrication and preparation of construction materials. These materials are generally not retrievable. However, they are not in short supply and their use will not have an adverse effect upon continued availability of these resources. Any construction will also require a substantial one-time expenditure of both State and Federal funds which are not retrievable.

The commitment of these resources is based on the concept that residents in the immediate area, region, and State will benefit by the improved quality services which are anticipated to outweigh the commitment of these resources.

5

Section 4(f) Evaluation

5.1 Introduction

Under Section 4(f) of the Department of Transportation Act as amended by the Federal-Aid Highway Act of 1968 (Public Law 90-495, 49 USC 1653), the Secretary of Transportation shall not approve any program or project which "requires the use of any publicly owned land from a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance as so determined by federal, state, or officials having jurisdiction thereof, or any land from a historic site of national, state or local significance as so determined by such officials unless (1) there is no feasible and prudent alternative to the use of such land, and (2) such program includes all possible planning to minimize harm to such park, recreation area, wildlife and waterfowl refuge, or historic site resulting from such use."

This combined Environmental Impact Statement (EIS) and Section 4(f) Evaluation provides the required documentation to demonstrate that there is no prudent and feasible alternative to affecting 4(f) resources in the form of historic resources. This evaluation also outlines the coordination that has occurred and the measures proposed to minimize harm to these resources.

5.2 Description of Selected Alternative

NHDOT, in planning this project, examined a large number of multimodal and highway improvement alternatives. After an initial screening, seven alternatives or combinations thereof were selected as a "reasonable range of alternatives." For more detailed evaluations, see Section 2.5. These included the No-Build Alternative; TSM measures, primarily ramp lengthening and lane widenings; widening I-93 in each direction to Four-Lanes, Three-Lanes, or a Four-Lane/Three-Lane Combination with the reduction of lanes after Exit 3; and TDM measures, including ITS technology, park-and-ride lots with bus terminal facilities, expanded bus service in the corridor, enhanced ride-sharing opportunities and commuter incentive programs, as well as employer-based measures to encourage people to not drive alone. Additional details on all of these alternatives can be found in Section 2.3.

The NHDOT's Selected Alternative involves a combination of transportation infrastructure improvements and strategies for the 19.8-mile study corridor. The Selected Four-Lane Alternative begins in the Town of Salem, NH at the Massachusetts/New Hampshire State line and extends northerly through Salem, Windham, Derry and Londonderry, and into Manchester, ending at the I-93/I-293 Interchange. See **Section 2.7** and **Figures 2.7-1 through 2.7-22** for details. In concert with the mainline widening to four lanes in each direction, the following infrastructure improvements were selected for the five interchanges and local roads within the project corridor:

- In the Exit 1 Interchange area, the existing Cross Street Bridge will be replaced with a new bridge located just to the north. This new bridge will be of sufficient length to accommodate a potential rail corridor west of I-93. The existing interchange at Exit 1 will be reconstructed to improve the substandard ramp geometry. (Figure 2.7-2)

- At Exit 2, the existing interchange is reconstructed to a diamond-type interchange configuration with new longer span bridges carrying I-93 over Pelham Road. Pelham Road will be widened and reconstructed from Policy Road to Stiles Road (Figure 2.7-4). Approximately 0.7 mile north of Exit 2, the Brookdale Road Bridge will be replaced on-line. (Figure 2.7-5)

- At Exit 3, both the northbound and southbound roadways of I-93 are relocated (referred to as the Tight Shift Option) into the existing median area. New longer span bridges will carry I-93 over NH 111 and NH 111A. The interchange ramps will be reconfigured with a diamond interchange design. NH 111A will be relocated on new alignment about 600 feet to the west of existing NH 111A. (Figures 2.7-7). NH 111 will be reconstructed and widened with the work beginning just west of the existing NH 111/NH 111A intersection and extending westerly through the Exit 3 Interchange to a point just west of the southbound ramps where NH 111 is relocated (Relocation Option) north of its existing location before tying into existing NH 111 near the Village Green Plaza intersection. (Figures 2.7-7 through 2.7-8)

- In the Exit 4 Interchange area, I-93 will be widened to the east, retaining the existing layout for the southbound ramps. The existing northbound ramps configuration will be retained and reconstructed. NH 102 will be reconstructed and widened from Londonderry Road to its intersection with the southbound on-ramp. The NH 102 bridge over I-93 will be replaced with a new, longer span bridge constructed directly south of the existing bridge. The Ash Street/ Pillsbury Road Bridge (Prowse Memorial Bridge) will be replaced with a new structure on-line. (Figures 2.7-14 through 2.7-15)

- At Exit 5, NH 28 will be widened and reconstructed on-line from west of Symmes Drive to just south of Liberty Drive including the reconstruction of the Perkins Road and Symmes Drive approaches, as well as the reconstruction of a portion of both Liberty and Independence Drives and a segment of the Auburn Road approach. The existing diamond interchange will be reconstructed and modernized. (Figures 2.7-17 through 2.7-18)

Three new park-and-ride lots are proposed with facilities planned at Exits 2, 3 and 5. The existing park-and-ride facility at Exit 4 will be retained and minor modifications would be made to the current parking layout to accommodate a new terminal building. Early construction of the park-and-ride facilities and the implementation of expanded bus service are proposed in advance of the highway widening to facilitate the maintenance of traffic.

- At Exit 2, the park-and-ride lot will be located adjacent to the interchange in the SE quadrant. (**Figure 2.7-4**)
- At Exit 3, the park-and-ride lot will be located easterly of, and adjacent to, the SE quadrant adjacent to the relocated northbound barrel. (**Figure 2.7-7)**
- At Exit 4, the existing facility will be retained and a new terminal building constructed. (**Figure 2.7-14**)
- At Exit 5, the park-and-ride lot will be located west of the interchange along the north side of NH 28 predominantly utilizing the Cycle World parcel and two other vacant parcels, with partial property impacts to the Waste Management, Exxon gas station, and Senior Care Center parcels. (**Figure 2.7-18)**

The NHDOT proposes to implement ITS technologies, as well as Incident Management strategies, for the I-93 corridor. Measures such as variable message boards, highway advisory radio broadcasts, web site information, emergency reference markers are under consideration, as well as greater coordination among NHDOT, State Police, and local emergency officials.

To further expand multimodal opportunities in the corridor, the NHDOT recently completed a separate Bikeway Feasibility Study to identify alternative transportation corridors for pedestrian and bicycle travel between Salem and Concord, NH. The study recommended the development of a rail trail facility located along the abandoned Manchester-Lawrence railroad corridor, located east of I-93. The Selected Alternative will also accommodate space within the highway corridor for a potential future rail line between the Exit 5 interchange and the MA/NH state line. The rail corridor could provide future rail service between Lawrence, MA or Woburn, MA (and ultimately Boston, MA) to the south and the Manchester Airport and/or the City of Manchester, NH to the north.

5.3 Description of Section 4(f) Resources

Full descriptions of National Register Eligible properties in the project area are included in Section 3.10.5.3. Depending on options chosen, Section 4(f) impacts could occur to the Kinzler House (SAL0204), Robert Armstrong House (WND0086), George Armstrong House (WND0085), George Dinsmore House (WND0033), Robert J. Prowse Bridge (LON0116), Woodmont Orchards Historic District (LON-D1), Reed Paige Clark Homestead (LON0114) and the Gearty House (LON0105).

5.4 Impacts on Section 4(f) Properties

All Section 4(f) impacts are historic, as no public parks, recreation areas or waterfowl and wildlife refuges will be affected.

The Selected Alternative, which is the Four-Lane Alternative with options as noted in Section 2.7.1, will result in Section 4(f) impacts to the Kinzler House property (SAL0204), Robert Armstrong House (WND0086), George Armstrong House (WND0085), Robert J. Prowse Memorial Bridge (LON0116), Reed Paige Clark Homestead (LON0114) and the Gearty House property (LON0105). Refer to Section 4.10.2.2 for information on Section 106 impacts. Figures 2.3-24 through 2.3-36 show the configuration of, and the impacts with, the Options described below.

Segment A

The Three-Lane and Four-Lane Alternatives and Combination Alternative will have a similar Section 4(f) impact on the 5.8-acre Kinzler House property (SAL0204), located on Cross Street (**Figure 5.4-1**). Some 2,200 square feet would be acquired for right-of-way. Approximately 1,200 square feet for slope work will be necessary, which will be contained within the proposed right-of-way.

Segment B

This segment would have no Section 4(f) impacts on historic resources.

Segment C

This segment would have no Section 4(f) impacts on historic resources.

Segment D

The tight-shift options (Options 7 through 9) with the Three-Lane, Four-Lane, and Combination Alternatives in Segment D will involve Section 4(f) impacts to two historic properties: the Robert Armstrong House (WND0086) and the George Armstrong House (WND0085), both located along the north side of NH 111A (Range Road) in Windham (**Figure 5.4-2**). Both properties will need to be acquired and the historic structures relocated or demolished.

Only Options 1, 2 and 7 in Segment D would have a Section 4(f) impact on the George Dinsmore House (WND0033) through slope work that would affect 1,500 square feet of the 1.1-acre eligible parcel .

Segment E

Impacts to three historic properties could occur in Segment E. The widening of the northbound and southbound lanes of I-93 will necessitate the replacement of the Robert J. Prowse Bridge (LON0116), which has been determined eligible for the

National Register (**Figures 5.4-3)**. Its loss would constitute a Section 4(f) impact through physical destruction of the historic structure.

The 196-acre Woodmont Orchards Historic District (LON-D1) will not be impacted by the Selected Alternative or its Easterly Option components. However, this parcel would be impacted by the Westerly Option by right-of-way acquisition of 5.4 acres along the west side of I-93, which includes slope impacts to 3.6 acres in the same area.

The 114.4-acre Reed Paige Clark Homestead (LON0114) on Stonehenge Road will be impacted by the loss (ROW acquisition) of approximately 2 acres of land within the eligible parcel along its boundary with I-93 due to right-of-way acquisition with the Three-Lane, Four-Lane, or Combination Alternative. The impact does not create an adverse effect, because the work will not affect any National Register eligible characteristics of the property. The eligible boundary was created by the initial construction of I-93 and is not the historic boundary of the property. Of the 2 acre impact, 0.2 acres of land will be physically affected by slope work with the Three-Lane and Combination Alternatives, while 0.4 acres of land will be affected by slope work with the Four-Lane Alternative (**Figure 5.4-4**). However, the work will not affect any National-Register eligible characteristics of the property because this area has been previously disturbed by construction and was not traditionally part of the agricultural operations because of its topography.

Segment F

The Three-Lane, Four-Lane and Combination Alternatives will have a similar Section 4(f) impact on the Gearty House property (LON0105), which contains 1.5 acres and is eligible for the National Register (**Figure 5.4-5**). This property will be affected by right-of-way acquisition of 100 square feet plus slope work on 365 square feet of the property.

5.5 Avoidance

Consideration was given in the planning process to shifts in the alignments to avoid 4(f) impacts. All alternatives avoid 4(f) impacts to the Armenian Settlement Historic District (SAL-D1), Indian Rock (WND0206), the Moody House (LON0117), the Shepard House (LON0103), and the Manchester Low-Service Pumping Station (MAN-D1). Only the No-Build Alternative avoids any 4(f) impacts to all historic properties. In Segment D, Options 1, 2, and 7 would have 4(f) impact on the George Dinsmore House (WND0033), while all remaining options for Segment D would avoid these impacts.

Specific avoidance alternatives for the impacted properties follow:

Kinzler House (SAL0204)

The impacts to the Kinzler House cannot be avoided because of the need to replace the existing Cross Street Bridge and its approaches. The new bridge and approach alignment was shifted northerly, away from the Kinzler House as much as practicable before transitioning and matching into existing Cross Street. Shifting Cross Street to avoid any impacts to the property would require the total realignment of Cross Street. This would result in additional impacts to adjacent properties, possibly resulting in some total acquisitions, and would introduce an angle point on Cross Street. The Three-Lane, Four-Lane, and the Combination Alternatives have identical 4(f) impacts to this property in this area. However, the impact is minor, consisting of repaving an existing paved area and will not change the National Register Eligible characteristics of the property.

George F. Armstrong House (WND0085)

For the Three-Lane, Four-Lane, and Combination Alternatives, only the Northbound Shift Option, which includes Options 1-6 in Segment D, avoids the loss of this historic property. There is no way to avoid the removal of the buildings under the Tight Shift Option, which includes Options 7-9 for the Three-Lane and Four-Lane Alternatives. The Tight Shift Option is a component of the Selected Alternative. Options 7-9 include the realignment of the northbound and southbound barrels of I-93 into the median area. The layout was developed at the Town of Windham's request to look at ways to reduce the Exit 3 Interchange footprint, similar to other interchanges along the corridor. With the Tight Shift Option, the mainline grade for the southbound roadway would be raised nearly 25 feet through the Exit 3 Interchange area to flatten and improve the existing steep downgrade from five-percent to approximately three-percent. The grade raise would improve the current undesirable geometric combination of a steep downgrade with relatively sharp horizontal curvature along the southbound roadway. The shift also moves the mainline away from both Cobbetts Pond and Canobie Lake (important recreational resources and in the case of Canobie Lake, the Salem drinking water supply), while allowing for the reconnection of previously bisected wetlands in the interchange area.

Robert Armstrong House (WND0086)

For the Three- and Four-Lane Alternatives, only the Northbound Shift Option, which includes Options 1-6 in Segment D, avoids the loss of this historic property. There is no way to avoid the removal of the buildings under the Tight Shift Option, which includes Options 7-9 for the Three-Lane, Four-Lane and Combination Alternatives. The Tight Shift Option is a component of the Selected Alternative. Options 7-9 include the realignment of the northbound and southbound roadways of I-93 into the median area. The layout was developed at the Town of Windham's request to look at ways to reduce the Exit 3 Interchange footprint to a smaller footprint similar to other interchanges along the corridor. With the Tight Shift Option, the mainline grade for the southbound roadway would be raised nearly 25 feet through the Exit 3

Interchange area to flatten and improve the existing steep downgrade from five-percent to approximately three-percent. The grade raise would improve the current undesirable geometric combination of a steep downgrade with relatively sharp horizontal curvature along the southbound roadway. The shift also moves the mainline away from both Cobbetts Pond and Canobie Lake (important recreational resources and in the case of Canobie Lake, the Salem drinking water supply), while allowing for the reconnection of previously bisected wetlands in the Exit 3 Interchange area.

George Dinsmore House (WND0033)

The widening of I-93 for the Three-Lane, Four-Lane, and Combination Alternatives avoids the Section 4(f) impact on this property. For any alternative, the only options along NH 111 that have slope impacts to the property are Options 1, 2, and 7 of Segment D. Selection of Options 3-6, 9, or the Selected Alternative, Option 8, would avoid these impacts.

Woodmont Orchards Historic District (LON-D1)

The Segment E, Easterly option avoids any slope and right-of-way impacts on the Woodmont Orchard property for the Three-Lane, Four-Lane, and Combination Alternatives. Segment E, Westerly option would have both slope and right-of-way impacts to this property under all alternatives. The Easterly and Westerly options refer to widening the I–93 mainline either all to east or to the west. These alternatives were developed to test the relative impacts of one option against the other, while trying to stay away from Wheeler Pond and the adjacent wetlands on the east and the Section 4(f) Woodmont Orchard property on the west. In addition, the Westerly option would require reconstruction of a portion of the existing Exit 4 park-and-ride lot as well as additional costs associated with reconstruction of the southbound ramps and ledge removal. The Selected Alternative incorporates the Easterly Option and therefore does not have any 4(f) impacts to the property (Figure 5.4-3).

Reed Paige Clark Homestead (LON0114)

All alternatives result in impact to this property (Figure 5.4-4). Considering the 114.4-acre size of this property, this effect is considered minimal. The land acquired is already disturbed and was not traditionally part of the agricultural operations of the property due to its topography.

Gearty House (LON0105)

All alternatives impact this property (Figures 5.4-5). Measures to minimize harm include minimizing acquisition and slope work, which limit impacts to the property.

Robert J. Prowse Memorial Bridge (LON0116)

There is no feasible way to avoid the necessity of replacing this bridge under the Three-Lane, Four-Lane, and Combination Alternatives. The existing span of the Prowse Bridge is not suitable to accommodate the proposed mainline widening for any of the Alternatives.

Several different considerations for the reuse and/or extension of the structure were evaluated and substantial design concerns resulted. These concepts include:

1. Extending the bridge by splicing new girders onto the eastern end of the bridge, thereby developing an additional span to cross over the proposed northbound lanes. This creates welding issues, as the existing steel is considerably different as compared to the type of steel presently specified for new bridge structures. Splicing and extension of the existing bridge would also alter the appearance of the overall structure and would compromise the historical integrity of the bridge.

2. Retaining and reusing the bridge at its present location to accommodate either the proposed north- or southbound barrel of I-93, by shifting the proposed alignment to either the east or the west (Figure 5.5-1). Both shifts would result in poor alignments and in substantial additional right-of-way acquisitions. The width of the proposed rail corridor would need to be reduced and elevation lowered, requiring retaining walls to protect the bridge's pier foundation. Furthermore, the west shift would entail additional wetland impacts, require realignment of Trolley Car Lane and would result in impacts to the Woodmont Historic District.

3. Removal and reuse at a different location along the I-93 corridor is problematic, since the field-welded splices and connections of the steel rigid frame structure would be difficult to dismantle in a manner that would allow effective and appropriate reassembly.

5.6 Measures to Minimize Harm

Kinzler House (SAL0204)

Impacts to this property have been minimized as much as feasible in project design.

The George F. Armstrong House (WND0085)

The only possible measure to minimize harm for the loss of this property under Options 7-9 of the Three-Lane, Four-Lane and Combination Alternatives is to acquire and record the building to HABS (Historic American Buildings Survey) standards. It will then be reconvened to the owner, or marketed to the public if the owner does not elect the reconveyance, with protective covenants for relocation in an appropriate setting. A portion of demolition costs would be allocated as an incentive for relocation. If efforts to market the house are unsuccessful, the building will be demolished.

Robert Armstrong House (WND0086)

The only measure to minimize harm for the loss of this property under Options 7-9 of any alternative is to acquire and record the house to HABS standards. Because of the high architectural quality and integrity of the house, the NHDOT will relocate it, if feasible, to a suitable setting as close to its current location as practicable. The NHDOT will conduct a building relocation study prior to the move. This study will be done at the time of the HABS documentation following the completion of the EIS process. The house will then be reconveyed to the owner, transferred to the Town or marketed to the public if the owner does not elect the reconveyance. The reconveyance will include protective preservation and maintenance covenants. The issue of relocating the house and maintaining its historic integrity will be reviewed with the property owner, the Windham Historical Commission, and the prospective owner of the dwelling in consultation with FHWA and NHDHR.

George Dinsmore House (WND0033)

Minimizing slope work is the only measure to minimize impact to this property under Options 1, 2 and 7.

Woodmont Orchards Historic District (LON-D1)

There is no mitigation for the adverse effect of right-of-way acquisition and slope work under Segment E-Westerly option.

Reed Paige Clark House (LON0114)

Considering the 114.4-acre size of the property and the fact that the characteristics that make the site eligible for the historic registration are not being affected, the impact to this property is considered minimal and mitigation efforts would have little benefit.

Robert J. Prowse Memorial Bridge (LON0116)

The NHDOT will replace the bridge with a steel rigid frame structure of compatible design. The measures to minimize the loss of this structure would be to record the bridge to HAER (Historic American Engineering Record) standards and market it for relocation. The availability of the bridge will be advertised for a period of time agreed to by FHWA, NHDOT and NHDHR. Federal-aid highway funds will be made available for its relocation up the estimated cost of its demolition. If marketing of the bridge is unsuccessful, the NHDOT will demolish the structure. An interpretive exhibit about its design and its fabrication will be developed in consultation with FHWA and NHDHR and displayed at the Salem Rest Area.

The original bridge plaque is to be retained with the bridge unless an adaptive use for the structure cannot be found, in which case it will either be placed in the interpretive exhibit at the Salem Rest Area or exhibited in the NHDOT lobby.

5.7 Coordination

Meetings were held among the State Historic Preservation Office (NHDHR), the Federal Highway Administration (FHWA), and the New Hampshire Department of Transportation (NHDOT) throughout the course of the project. Determinations of National Register Eligibility were made at meetings on February 13 and 27, 2002, and Determinations of Effect were made by consensus on March 14, 2002. An Effect Memo was signed on August 8, 2002. Coordination meetings on the appropriate mitigation were held on September 11, 2003 and December 11, 2003. A Memorandum of Agreement was signed on February 6, 2004 (see Appendix G).

Coordination has been established with the US Department of the Interior (USDOI) regarding Section 4(f) issues. On December 30, 2002, the USDOI commented on the DEIS indicating that they concurred that there are no prudent and feasible alternatives to the Preferred Alternative (which had the same 4(f) impacts as the Selected Alternative) subject to necessary completion of a Memorandum of Agreement with the State Historic Preservation Officer.

5.8 Summary Statement

Based upon the above considerations, there are no feasible and prudent alternatives to the use of land from Section 4(f) properties, and the proposed action includes all planning to minimize harm to these properties resulting from such use.

6

List of Preparers

6.1 List of Preparers including their Responsibilities and Qualifications

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Vanasse Hangen Brustlin, Inc.

Name /Title: Mr. Bruce Tasker, P.E., Project Manager

Qualifications: A.S. in Civil Technology from Wentworth Institute, B.S. in Civil Engineering from New England College. Over 30 years experience in preliminary and final design.

Responsibilities: Consultant Team Manager. Overall supervision of corridor design development.

Name /Title: Dr. William J. Barry, Senior Environmental Scientist

Qualifications: Ph.D. in Zoology from Michigan State University with emphasis in ecology and animal behavior. Certified Wildlife Biologist and Certified Wetland Scientist (NH). Over 20 years experience as an environmental consultant.

Responsibilities: Chief Editor of the EIS. Overall supervision of the EIS.

Name /Title: Mr. Anthony Grande, P.E., Assistant Project Manager, Senior Highway Engineer

Qualifications: B.S. in Civil Engineering from the University of Lowell. Seventeen years experience in surveying and civil engineering primarily related to preliminary and final design of transportation facilities.

Responsibilities: Oversaw development of design for project alternatives.

Name /Title: Mr. Martin Kennedy, P.E., Senior Traffic Engineer

Qualifications: B.S. in Civil Engineering from Northeastern University.
Over 15 years experience in transportation planning, traffic operations, and traffic impact assessment.

Responsibilities: Oversaw traffic operations evaluation.

Name /Title: Mr. Howard Muise, Senior Transportation Planner

Qualifications: B.A. in Liberal Arts from Northeastern University,
M.S.P. in Transportation Planning from Florida State University.
Over 23 years experience in transportation planning, traffic impact studies, and travel demand projections.

Responsibilities: Oversaw development of ridership estimates for bus, rail, and HOV alternatives.

Name /Title: Mr. Michael Leo, P.E., L.L.S., Senior Hydraulic Engineer

Qualifications: B.S. in Structural Design and Construction Engineering Technology from Pennsylvania State University.
Twenty years experience in civil engineering and survey.

Responsibilities: Performed drainage design and floodplain analysis.

Name /Title: Mr. Senan Murdock, P.E., Highway Engineer

Qualifications: B.S. in Civil Engineering from University of Vermont.
Eleven years experience in highway engineering.

Responsibilities: Developed conceptual designs, including bike pathway.

Name /Title: Mr. Thomas Wholley, Air and Noise Specialist

Qualifications: B.S. in Civil Engineering from Lowell Technological Institute.
Over 25 years experience in preparing and reviewing air quality and noise analyses.

Responsibilities: Authored air quality and noise sections.

Name /Title: Mr. Peter Walker

Qualifications: B.A. in Biology and Environmental Studies, Williams College,
M.S. in Biology, University of Vermont,
Certified Wetland Scientist (NH).
12 years experience in environmental science and impact analysis.

Responsibilities: Reviewed wetlands and vernal pool analysis, co-authored visual resources, authored threatened and endangered species.

Name /Title: Mr. Jacob Tinus

Qualifications: B.S. in Biology, University of New York at Potsdam, M.S. in Environmental Resource Management and Administration, Antioch/New England Graduate School, Keene, New Hampshire.

Responsibilities: Conducted wetlands function and value assessments and wetlands mitigation site assessments. Authored wetlands and vernal pool descriptions and impact sections.

Name /Title: Mr. John Prenosil, Stream Ecologist

Qualifications: M.S. in Fisheries and Wildlife Ecology and B.S. in Environmental Biology and Toxicology from University of Massachusetts-Amherst. Seven years experience in environmental assessment and impact studies, ecological analysis, and related investigations.

Responsibilities: Conducted stream surveys and authored aquatic life sections.

■

Parsons Brinckerhoff Quade and Douglas, Inc

Name /Title: Mr. Samuel Seskin, Senior Supervising Planner

Qualifications: B.A. from Yale College and Master of Public Affairs in Urban Planning from Woodrow Wilson School of Public and International Affairs, Princeton University. Twenty-seven years experience in the assessment of transportation, economic development, land use, and economic impacts at all levels of government.

Responsibilities: Oversaw Expert Panel establishment and secondary impacts evaluation.

Name /Title: Mr. Allan Hodges, FAICP, Senior Planner

Qualifications: B.S. in Community Development from Southern Illinois University and M.S. in Urban Planning from Michigan State University. Over 33 years in urban and land use planning and preparation of environmental documentation meeting NEPA requirements for transportation and other infrastructure projects.

Responsibilities: Project Manager for Expert Panel recruiting, management and support and preparation of Secondary Land Use Impacts section of EIS.

Name /Title: Mr. Erik Balsley, Planner/GIS Analyst

Qualifications: B.S. and M.S. Degrees in City Planning (1997) from Massachusetts Institute of Technology.
Over four years experience in urban planning, geographic information systems and data analysis and reporting.

Responsibilities: Catalogued GIS data, produced maps and assisted in preparing the Briefing Book and obtaining additional data for the Expert Panel. Assisted in preparation of the Secondary Land Use Impacts section of the EIS.

■

ENSR International

Name /Title: Mr. Budd Titlow, Senior Environmental Scientist

Qualifications: Masters of Science Degree. Also Professional Wetland Scientist.

Responsibilities: Project Manager for original environmental studies.

Personnel /Title: Ms. Julia Stearns, Environmental Scientist

Qualifications: B.S. in Biology.

Responsibilities: Conducted wetlands and wildlife studies.

Name /Title: Ms. Erin Haney, Environmental Scientist

Qualifications: B.S. in Environmental Science.

Responsibilities: Conducted wetlands, wildlife and T&E species studies and farmland evaluation.

Name /Title: Ms. Amy Schoenfeld, Environmental Scientist

Qualifications: B.S. in Biology.

Responsibilities: Conducted wetlands, wildlife and T&E species studies.

Name /Title: Ms. Carol-Anne Morse, Senior Geologist

Qualifications: B.A. in Earth Sciences from Lafayette College, PA and M.S. in Earth Science – Biogeochemical Systems from University of New Hampshire.

Responsibilities: Senior QA/QC prior to final report production. Project Management.

Name /Title: Ms. Cheryl Anne Cormier, Senior Geologist

Qualifications: B.S. in Geological Sciences from Salem State College, Massachusetts.

Responsibilities: QA/QC for report preparation; hazardous materials studies.

■

Great Bay Environmental Consulting

Name/Title: William R. Arcieri, Senior Water Resource Scientist

Qualifications: B.S. in Hydrology from University of New Hampshire and M.S. in Water Resources from University of Rhode Island. Over 15 years experience in the assessment of water quality impacts associated with stormwater and non-point pollution sources.

Responsibilities: Performed surface and groundwater impact analyses and authored same sections of the EIS.

■

Municipal Resources, Inc.

Name /Title: Mr. Stephen Griffin, AICP, Sr. Associate, Municipal Res. Inc

Qualifications: Bachelor of Architecture from NC State University, Masters of Regional Planning from UNC-Chapel Hill, and Masters of Urban Administration from UNC-Charlotte, with 25 years experience with public planning agencies and 8 years with MRI.

Responsibilities: Researched and authored socio-economic resources sections of the EIS.

■

Preservation Company

Name /Title: Ms. Lynne Monroe, Architectural Historian

Qualifications: B.F.A. from University of Pennsylvania, advanced study in Historic Preservation at Boston University. 19 years experience in historic preservation. Experience in historic architectural surveys and National Register nominations.

Responsibilities: Authored historic resources section.

■

New Hampshire Department of Transportation

Name /Title: Mr. David J. Brillhart, P.E., Director of Project Development

Qualifications: B.S. in Civil Engineering from University of New Hampshire. Over 20 years experience in transportation engineering.

Responsibilities: Overall project coordination and management.

Name /Title: Mr. William J. Cass, P.E., Chief Project Manager

Qualifications: B.S. in Civil Engineering from University of New Hampshire. 16 years experience in highway design engineering.

Responsibilities: Reviewed engineering design and traffic and transportation section.

Name /Title: Mr. John Butler, P.E., Supervisor Preliminary Design, Bureau of Highways

Qualifications: B.S. Civil Engineering from Clarkson College. 15 years experience in transportation engineering.

Responsibilities: Reviewed engineering design plans.

Name /Title: Dr. Subramanian N. Sharma, Traffic Research Engineer

Qualifications: Ph.D. in Civil Engineering, University of Massachusetts-Amherst 15 years experience in transportation planning and traffic analysis.

Responsibilities: Reviewed traffic and transportation section.

Name /Title: Mr. Marc Laurin, Senior Environmental Manager, Bureau of Environment

Qualifications: B.A. in Biology from Potsdam State University of New York. 14 years experience in environmental impact assessment and document preparation with specialized training in wetlands analysis.

Responsibilities: Reviewed environmental resources sections.

Name /Title: Dr. Joyce McKay, Historian, Bureau of Environment

Qualifications: B.A. in Anthropology from Indiana University, MA in History Museum Studies from Cooperstown Graduate

	programs (SUNY – Oneonta), PhD in Anthropology with specialization in historical archaeology from Brown University. 28 years experience in historic building management, archaeological survey, and Section 106 and 4(f) coordination.
Responsibilities:	Wrote archaeological sections. Coordinated historical and archaeological review.

Name /Title:	Mr. Charles Hood, Chief, Project Development Section Bureau of Environment
Qualifications:	B.S. in Forestry from University of New Hampshire. 29 years experience in environmental impact assessment and document preparation, with specialized training in noise analysis.
Responsibilities:	Principal Reviewer

Name /Title:	Mr. Russell A. St. Pierre, Senior Environmental Manager, Bureau of Environment
Qualifications:	A.A.S. in Forestry from Paul Smith College; B.S. in Computer Science from Franklin Pierce College. 9 years experience in Air Quality Analysis and Noise Analysis.
Responsibilities:	Reviewed air quality and noise analysis sections of EIS.

Name /Title:	Mr. Dale O'Connell, Contamination Project Manager, Bureau of Environment
Qualifications:	B.A. in Earth Science from University of New Hampshire 9 years of geotechnical experience, 3 years of hazardous materials investigation and analysis.
Responsibilities:	Reviewed hazardous materials section of the EIS.

■

Federal Highway Administration

Name /Title:	Mr. William F. O'Donnell., P.E., Environmental Program Manager
Qualifications:	B.S. in Civil Engineering from Northeastern University. Over 35 years experience with additional training in air and noise analysis, water quality, ecological impacts, historic and archaeological preservation, and hazardous materials studies.
Responsibilities:	Principal Reviewer of highway design concepts and EIS preparation.

Name /Title:	Mr. Harry S. Kinter, Special Programs Manager
Qualifications:	B.A. in History from Pennsylvania State University. M.A. in History from Indiana University of Pennsylvania. 32 years experience including specialized training in appraisal, relocation assistance, administration and management, historic and archaeological preservation, hazardous materials studies, social impacts, aesthetic impacts, and landscaping.
Responsibilities:	Reviewed cultural resources, socio-economic, and hazardous materials sections.

7

List of Agencies, Organizations and Persons to Whom Copies of the Draft and/or Final Environmental Impact Statement Were Sent

7.1 Federal Agencies

Director, Office of Environmental Policy and Compliance
U.S. Department of the Interior
Main Interior Building, MS 2340
1849 C Street, NW
Washington, DC 20240

U.S. Environmental Protection Agency
Office of Federal Activities
NEPA Compliance Division, EIS Filing Section
Mail Code 2252-A
401 M Street, SW
Washington, DC 20460

Environmental Protection Agency, Region I
John F. Kennedy Federal Building
Mail Code RAA, Room 2203
Boston, MA 02203

Regional Administrator, Region I
Dept. of Housing & Urban Development
John F. Kennedy Building
Boston, MA 02203

Exec. Director, Advisory Council on Historic Preservation
Office of Planning and Review
Old P. O. Bldg., Suite 809
1100 Pennsylvania Avenue, NW
Washington, DC 20004

Office of the Secretary
Department of Agriculture
Room 200A
14th and Independence Avenue, SW
Washington, DC 20250

Regional Director – Region I
Room 462
Federal Emergency Mgmt. Agency
J.W. McCormack P.O. & Court House
Boston, MA 02109

U.S. Army Corps of Engineers
Environmental Analysis Branch
New England District
696 Virginia Road
Concord, MA 01742-2751

U.S. Army Corps of Engineers
Regulatory Branch
696 Virginia Toad
Concord, MA 01742-2751

Director, New England Region
Federal Aviation Administration
12 New England Executive Park
Burlington, MA 01803

Federal Energy Regulatory Comm.
Environmental Evaluation Branch
825 N. Capital Street, NE
Room 7102
Washington, DC 20426

Federal Railroad Administration
Intermodal Freight Industry Analysis
Division (RRP-13)
400 Seventh Street, SW
Washington, DC 20590

Regional Administrator
Federal Transit Administration
DOT Transportation Systems Center
Kendall Square
Cambridge, MA 02142-1093

Director
Office of Policy and Strategic Planning
National Oceanic & Atmospheric Admin.
U.S. Dept. of Commerce – Room 5805
14th and Constitution Avenue, NW
Washington, DC 20230

Regional Director
Northeastern Region
National Marine Fisheries Svcs
1 Blackburn Drive
Gloucester, MA 01930

Division of NEPA Affairs
Dept. of Energy
Room 4 G 064
1000 Independence Avenue, SW
Washington, DC 20585

Michael Bartlett
US Fish & Wildlife Service
70 Commercial Street
Suite 300
Concord, NH 03301-5087

U.S. Department of Interior
Geological Survey,
NH/VT District
361 Commerce Way
Pembroke, NH 03275

Richard Babcock, State Conservationist
Natural Resources Conservation Svc.
Federal Building
2 Madbury Rd.
Durham, NH 03824-2043

District Conservationist
Natural Resources Conservation Svc.
Hillsborough County Conservation District
Chappell Professional Center
468, Route 13 South
Milford, NH 03055

District Conservationist
Natural Resources Conservation Svc.
Rockingham County Conservation District
110 North Road
Brentwood, NH 03833-6614

7.2 State Agencies

Commissioner Stephen H. Taylor
NH Department of Agriculture
PO Box 2042
Concord, NH 03302-2042

Office of the Attorney General
Environmental Section
Bank Building, 33 Capitol Street
Concord, NH 03301

Collis Adams, Administrator
Wetlands Bureau, Water Resources Division
NH Dept. of Environmental Services
6 Hazen Drive
Concord, NH 03301

David Neils, Rivers Coordinator
NH Dept. of Environmental Services
NH Rivers Protection Program
6 Hazen Drive
Concord, NH 03301

James McConaha
NH Div. of Historic Resources
Dept. of Cultural Affairs
19 Pillsbury Street
Concord, NH 03301

Philip J. O'Brien, Director
Waste Management Division
NH Dept. of Environmental Services
6 Hazen Drive
Concord, NH 03301

Lionel Chute
Dept. of Resources & Econ. Dev.
NH Natural Heritage Program
172 Pembroke Road
Concord, NH 03301

Harry Stewart, Director
Water Division
NH Dept. of Environmental Services.
6 Hazen Drive
Concord, NH 03302-0095

Dept. of Resources & Econ. Dev.
Parks and Recreation Division
Bureau of Off Highway Vehicles
172 Pembroke Road
Concord, NH 03301

Director, Division of Forest & Lands
NH Dept. of Resources & Economic Development
172 Pembroke Road
Concord, NH 03301

Mary Ann Manoogian, Director
NH Office of Energy and Planning
57 Regional Drive
Concord, NH 03301

Director, Div. of Parks & Recreation
NH Dept. of Resources & Economic Dev.
172 Pembroke Road
Concord, NH 03301

Commissioner Michael Nolin
NH Dept. of Environmental Services
6 Hazen Drive
Concord, NH 03301

Director
Division of Air Resources
NH Dept. of Environmental Services
64 North Main Street
Concord, NH 03301

Commissioner George M. Bald
NH Dept. of Resources and Economic Development
172 Pembroke Road
Concord, NH 03301

Executive Director
NH Fish & Game Department
2 Hazen Drive
Concord, NH 03301

Office of the Attorney General
Eminent Domain Section
Bank Bldg., 33 Capitol Street
Concord, NH 03301

Governor Craig Benson
Office of the Governor
Room 208–214, State House
Concord, NH 03301

Executive Councilor Ruth L. Griffin
Room 207, State House
Concord, NH 03301

Executive Councilor Richard Wheeler
Room 207, State House
Concord, NH 03301

Executive Councilor Peter J. Spaulding
Room 207, State House
Concord, NH 03301

Executive Councilor Raymond S. Burton
Room 207, State House
Concord, NH 03301

Executive Councilor Raymond Wieczorek
Room 207, State House
Concord, NH 03301

State Library
20 Park Street
Concord, NH 03301

U.S. Senator John E. Sununu
1750 Elm Street
Manchester, NH 03104

U.S. Representative Charles Bass
142 North Main Street
Concord, NH 03301

U.S. Senator Judd Gregg
Norris Cotton Federal Building
Manchester, NH 03103

U.S. Representative Jeb Bradley
1095 Elm Street
Manchester, NH 03101

NH Office of Emergency Management
State Office Park South
107 Pleasant Street
Concord, NH 03301

7.3 Others (Including Local and Regional Organizations)

Town of Salem
-- Board of Selectmen
-- Town Administrator
-- Planning Board
-- Conservation Commission
-- Town Library
-- Town Manager
-- Historic District Commission

Town of Windham
-- Board of Selectmen
-- Town Administrator
-- Planning Board
-- Conservation Commission
-- Town Library
-- Historic District/Heritage Commission

Cliff Sinott, Executive Director
Rockingham Planning Commission
156 Water Street
Exeter, NH 03833

Manindra Sharma, Executive Director
Southern New Hampshire Planning Commission
438 Dubuque St.
Manchester, NH 03102-3546

Andrew Singelakis, Executive Director
Nashua Regional Planning Commission
115 Main Street
PO Box 847
Nashua, NH 03061

Gar R. Carlson
Canobie Lake Protective Association
41 Lake Shore Road
Salem, NH 03079

Town of Derry
-- Board of Selectmen
-- Town Administrator
-- Planning Board
-- Conservation Commission
-- Town Library

Town of Londonderry
-- Board of Selectmen
-- Town Administrator
-- Planning Board
-- Conservation Commission
-- Town Library
-- Historic District Commission

City of Manchester
-- Mayor' Office
-- Board of Aldermen
--Planning Staff
--Public Works Staff
-- Conservation Commission
-- City Library

Audubon Society of New Hampshire
3 Silk Farm Road
Concord, NH 03301

Sierra Club - NH Chapter
3 Bicentenial Square
Concord, NH 03301

Conservation Law Foundation
Concord Advocacy Center
27 North Main Street
Concord, NH 03301-4930

City of Methuen
Mayor's Office
Searles Building, Room 305
41 Pleasant Street, 3rd Floor
Methuen, MA 01844

J. Andrew Manning
Crystal Lake Preservation Association
27 Fremont Street
Manchester, NH 03013

AAA Northern New England
P.O. Box 3544
Portland, ME 04104

Society for the Protection of New Hampshire Forests
54 Portsmouth Street
Concord, NH 03301

Gaylord Burke, Executive Director
Merrimack Valley Planning Commission
160 Main Street
Haverhill, MA 01830-5000

Northern Middlesex Council of Governments
Gallagher Transportation Terminal, Floor 3B
115 Thorndike Street
Lowell, MA 01852-3308

Donna Nelson
Spicket River Flood Mitigation Committee
Massachusetts Department of Environmental Management
251 Causeway Street, Suite 600-700
Boston, MA 02114-2104

Thomas F. Broderick, P.E.
Chief Engineer
Massachusetts Highway Department
Transportation Building – Suite 3510
10 Park Plaza
Boston, MA 02116-3973

James H. Scanlon
Secretary and MBTA Chairman
MA Exec. Ofc. of Transportation and Construction
Transportation Bldg., Suite 3150
10 Park Plaza
Boston, MA 02116-3969

American Automobile Association
89 March Avenue
Manchester, NH 03103

Carolyn Marcer-McFadden
NH Sierra Club
PO Box 328
New Ipswich, NH 03071

Joseph Giarusso
Conservation Department
City of Methuen, Searles Building
Methuen, MA 01844

In addition, excerpts from the DEIS, including sections on Secondary Growth (4.12) and Compensatory Wetland Mitigation (4.6.2.4) were sent to the following New Hampshire communities. Copies of the FEIS are being provided as well.

Allenstown
Atkinson
Auburn
Bedford
Bow
Candia
Chester
Concord
Danville
Deerfield
Dunbarton
Goffstown
Hampstead
Hooksett
Pelham
Pembroke
Raymond
Sanborn

7.4 Agencies, Organizations and Individuals Who Provided Comments on the DEIS

Federal

*Mr. John R. Kennelly
Chief Planning Branch
Dept. of the Army, NE District
Corps of Engineers
696 Virginia Road
Concord, Massachusetts 01742-2751

Mr. Robert W. Varney
Regional Administrator
U.S. Environmental Protection Agency
Region 1
1 Congress Street
Boston, Massachusetts 02114-2023

Mr. Willie R. Taylor, Director
Office of Environmental Policy and Compliance
United States Department of Interior
Office of the Secretary
Washington, D.C. 20240

State

Mr. William S. Bartlett Jr.
Executive Director
New Hampshire Fish and Game Dept.
2 Hazen Drive
Concord, NH 003301-6500

Mr. George Dana Bisbee
Acting Commissioner
State of New Hampshire
Department of Environmental Services
6 Hazen Drive, P.O. Box 95
Concord, New Hampshire 03302-0095

Representative Robert J. Letourneau
District 77 – Derry, NH
State of New Hampshire
State House
Concord, New Hampshire 03301

Rep. Anthony R. DiFruscia
Rockingham County, District 76
State of New Hampshire
House of Representatives
Concord, New Hampshire 03301

Sen. Theodore L. Gatsas (Manchester)
Rep. Ray F. Langer (Hooksett)
Rep. Stephen L'Heureux (Hooksett)
Rep. David W. Hess (Hooksett)
Rep. James Oliver (Hooksett)
State of New Hampshire
General Court
Concord, New Hampshire 03301

Mr. James H. Scanlan
Secretary of Transportation
The Commonwealth of Massachusetts
Executive Office of Transportation and Construction,
10 Park Plaza
Boston, Massachusetts 02116-3969

Local

Mr. Jeffrey C. Towne
Town Manager
Town of Salem
33 Geremonty Drive
Salem, New Hampshire 03079

Ms. Margaret Crisler, Chairman
Town of Windham Selectmen
Planning and Development
P.O. Box 120
Windham, New Hampshire 03087

Mr. John Silvestro, Chairman Town Council
Londonderry Town Council
50 Nashua Road, Suite 100
Londonderry, NH 03053-3416

Mr. James Anagnos
Chairman Planning Board
Londonderry Planning Board
50 Nashua Road, Suite 100
Londonderry, NH 03053-3416

Mr. Andre L. Garron, AICP, Director
Londonderry Planning & Economic Development
50 Nashua Road, Suite 100
Londonderry, NH 03053-3416

Ms. Deborah Lievens, Chair
Londonderry Conservation Commission
50 Nashua Road – Suite 100
Londonderry, NH 03053-3416

Mr. Paul Doolittle, Chair
Derry Town Council
14 Manning Street
Derry, New Hampshire 03038

Mr. William Hoyt, Secretary
Derry Conservation Commission
14 Manning Street
Derry, New Hampshire 03038-3208

Mr. Daniel P. O'Neil, Alderman At-large
State Senator – District 18
City of Manchester
One City Hall Plaza
Manchester, New Hampshire 03101

Mr. Armand Forest
Alderman – Ward 12
Manchester Board of Aldermen
One City Hall Plaza
Manchester, New Hampshire 03101

Mr. Frank C. Thomas, P.E.
Public Works Director
Manchester Department of Highways
227 Maple Street
Manchester, New Hampshire 03103-5596

Mr. Robert S. MacKenzie, Director
Manchester Planning and Community Development
One City Hall Plaza
Manchester, New Hampshire 03101

Ms. Sally Wilkins, Chairman
Amherst Planning Board
Amherst, New Hampshire

Mr. John A. Harvey, Chairman
Amherst Conservation Commission
Amherst, New Hampshire

Ms. Deirdre Cleary
Auburn Conservation Commission
P.O. Box 309
Auburn, New Hampshire 03032-0309

Mr. Andrew Hadik, Chairman
Chester Planning Board
Municipal Office Bldg.
84 Chester Street – P.O. Box 217
Chester, New Hampshsire 03036

Ms. Maureen M. Lein, Selectman
Chester Board of Selectmen
P.O. Box 275
Chester, New Hampshire 03036

Mr. Charles Myette, Chair
Chester Conservation Commission
Municipal Office Bldg.
84 Chester Street – P.O. Box 275
Chester, New Hampshsire 03036

Mr. Roger C. Hawk
Community Development Director
Concord Community Development Department
City Hall
41 Green Street
Concord, New Hampshire 03301

Mr. Wes Golomb
Deerfield Conservation Commission
P.O. Box 230
Deerfield, New Hampshire 03037

Mr. Erik E. Gross
Deerfield Open Space Committee
18 Nottingham Road
Deerfield, New Hampshsire 03037

Mr. Edward M. Cobbett, Chairman
Deering Conservation Commission
Deerfield Town Hall
762 Deering Center Road
Deerfield, New Hampshsire 03244

Mr. Charles Graybill, Chairman
Town of Dunbarton
Office of the Selectmen
1011 School Street
Dunbarton, New Hampshire 03046-4816

Mr. John R. Swindlehurst III
Town of Dunbarton
Office of the Selectmen
1011 School Street
Dunbarton, New Hampshire 03046-4816

Mr. Leslie Hammond
Town of Dunbarton
Office of the Selectmen
1011 School Street
Dunbarton, New Hampshire 03046-4816

Mr. Robert Wheeler, Chairman
Goffstown Board of Selectmen
16 Main Street
Goffstown, New Hampshire 03045

Mr. James F. Raymond, Chairman
Goffstown Planning Board
Town Offices
16 Main Street
Goffstown, New Hampshire 03045

Mr. Tim Johnson, Chairman
Hooksett Conservation Commission
16 Main Street
Hooksett, New Hampshsire 03106

Mr. Michael J. DiBitetto, Chairman
Hooksett Town Council
16 Main Street
Hooksett, New Hampshire 03106

Mr. Carl E. Hedberg, Chairman
Mont Vernon Conservation Commission
Mont Vernon, New Hampshire 03057

Regional/ Regional Planning Commissions

Mr. Cliff Sinott, Executive Director
Rockingham Planning Commission and Salem-Plaistow-Windham MPO
156 Water Street
Exeter, New Hampshire 03833

Mr. M.N. Sharma, Executive Director
Southern NH Planning Commission
438 Dubuque Street
Manchester, New Hampshire 03102-3546

Mr. Andrew Singelakis, Executive Director
Nashua Regional Planning Commission
P.O. Box 847
115 Main Street
Nashua, New Hampshire 03061

Mr. Michael Tardiff, Executive Director
Central NH Regional Planning Commission
28 Commercial Street
Concord, New Hampshire 03301

Mr. Gaylord Burke, Executive Director
Merrimack Valley Planning Commission
160 Main Street
Haverhill, Massachusetts 01830

Private Organizations/Individuals

Mr. Thomas F. Irwin, Staff Attorney
Conservation Law Foundation
New Hampshire Advocacy Center
27 N. Main Street
Concord, New Hampshire 03301-4930

Ms. Laura Deming, Sr. Wildlife Biologist
Audubon Society of New Hampshire
3 Silk Farm Road
Concord, New Hampshire 03301

Mr. Josh Irwin, Director
NH Public Interest Research Group
80-1/2 N. Main Street
Concord, New Hampshire 03301

Mr. Richard Katzenburg
Sierra Club – New Hampshire Chapter
97 Boston Post Road
Amherst, New Hampshire 03031

Mr. Charles R. Niebling, Senior Director
Policy and Land Management
Society for the Protection of NH Forests
54 Portsmouth Street
Concord, New Hampshire

Mr. Bruce B. Clendenning
NH Conservation Advocate
Appalachian Mountain Club
54 Portsmouth Avenue
Concord, New Hampshire 03301

Ms. Beth Brazil, Executive Director
Merrimack River Watershed Council
181 Canal Street, P.O. Boc 1377
Lawrence, Massachusetts 01842-2577

Mr. David Schaarsmith
Environmental Policy Director
New Hampshire Lakes Association
5 South State Street
Concord, New Hampshire 03301

Mr. Jed Callen, President
Piscataquog Watershed Association
5A Mill Street
New Boston, New Hampshire 03070

Mr. Donald Clement, Chair
Exeter River Local Advisory Committee
156 Water Street
Exeter, New Hampshire 03833

Ms. Priscilla Mattson, Ph.D
Hackett Hill Issue Chair
NH Sierra Club
144 West Webster Street
Manchester, New Hampshire 03104

Ms. Alice Desouza
Bedford, New Hampshire

Mr. William H. Dunlap
Amherst, New Hampshire

Mr. Martin L. Gross
Former Mayor of Concord
Member Concord Planning Board
Concord, New Hampshire 03301

Dr. Dennis Meadows, Director
Institute for Policy and Social Science Research
University of New Hampshire
Durham, New Hampshire

Hon. Paul D. Spiess
State Representative
Amherst, NH

Mr. Felix M. Torres Executive Director
Manchester Neighborhood Housing Services
Manchester, New Hampshire

Ms. Abby Williamson
Masters Candidate
Kennedy School of Government
Harvard University
Cambridge, Massachusetts

Mr. Kenyon F. Karl
17 Ephraim Page Road
Wentworth, New Hampshire 032382-3224

Ms. Katharine Gormly
Groundwork Spicket River Task Force Coordinator
60 Island Street
Lawrence, Massachusetts 01840

Mr. Robert A. Joubert
9 Sycamore Road
Methuen, Massachusetts 01844

J. Mark Lennon
461 Pumpkin Hill Road
Warner, New Hampshire 03278

Mr. Andrew P. Duncan, Ph.D.
16 Kimball Street
Concord, New Hampshire 03301-2868

Ms. Kirsten Kapp
Project Assistant
Northeast Natural Resource Center
National Wildlife Federation

8

Comments and Coordination

8.1 Advisory Task Force Meetings

At the outset of the project an Advisory Task Force (ATF) was created with the appointment by local governing boards of two people from each community. In addition, one person each from the RPC, SNHPC and NRPC served on the ATF. The ATF was established to assist the NHDOT in identifying issues and possible solutions regarding the project's purpose and need. Over time, the meetings evolved into largely public informational meetings involving ATF members, public officials and the general public, principally from the community within which the meeting was held. The dates, locations and topics of these ATF meetings were:

Meeting No.	Date/Location	Topics
1	Wednesday, March 22, 2000 Southern NH Planning Commission, Manchester	Kickoff Meeting - Role of Advisory Task Force and Scope of Project
2	Thursday, May 4, 2000 Londonderry Town Offices	Preliminary Overview of Rail Alternatives
3	Thursday, June 1, 2000 Fisk School, Salem	I-93 Engineering Concepts: Exit 1 and Exit 2
4	Thursday, June 22, 2000 Searles School, Windham	I-93 Engineering Concepts: Exit 3
5	Thursday, July 27, 2000 West Running Brook School, Derry	I-93 Engineering Concepts: Exit 4 to I-293
6	Thursday, September 14, 2000 McLaughlin Middle School, Manchester	I-93 Ridership, Rail, Bus, HOV
7	Thursday, October 12, 2000 Fisk School, Salem	HOV Ridership/Mode Options/ I-93 LOS
8	Thursday, November 9, 2000 West Running Brook School, Derry	Ridership Conclusions Reached; Exits 1-3 Design Concepts Recommendations
9	Thursday, March 29, 2001 Fisk School, Salem	Conceptual Designs-MA line through Exit 2

Meeting No.	Date/Location	Topics
10	Thursday, April 26, 2001 Windham Middle School, Windham	Conceptual Designs-Segment 2 of Phase III design (Exit 3 area)
11	Thursday, May 24, 2001 Matthew Thornton Elementary School, Londonderry	Conceptual Designs-Segment 3 of Phase III design (Exit 4 area)
12	Thursday, June 28, 2001 Londonderry	Conceptual designs-Segment 4 of Phase III design (Exit 5 area)

8.2 Resource Agency Meetings

Throughout the EIS process, a number of meetings were held with the various Federal and State resource agencies including USACOE, USEPA, USFWS, NHF&GD, NHDES, and NHDHR, to receive their guidance and feedback on issues related to the project. Following circulation of the DEIS several additional meetings were held with various resource agencies to discuss specific issues of concern. The dates, location and topics for these meetings are listed below:

Meeting No.	Date/Location	Topics
1	Wednesday, January 20, 2000 New Hampshire Department of Transportation, Concord	Project Overview
2	Wednesday, February 16, 2000 New Hampshire Department of Transportation, Concord	Project Status, Design Considerations – Exits 1 & 2
3	Wednesday, May 17, 2000 New Hampshire Department of Transportation, Concord	Review Conceptual Design Alternatives, Stateline through Exit 2
4	Wednesday, June 14, 2000 New Hampshire Department of Transportation, Concord	Review Conceptual Design Alternatives; Exit 2 through Exit 3 w/Park & Ride Lots
5	Wednesday, July 19, 2000 New Hampshire Department of Transportation, Concord	Review Conceptual Design Alternatives, Exit 4 to I-293
6	Wednesday, August 16, 2000 New Hampshire Department of Transportation, Concord	Ridership Options and Projections; Rail, Bus, HOV

Meeting No.	Date/Location	Topics
7	Wednesday, September 20, 2000 West Running Brook Middle School, Derry	Mode Options/Ridership Effects on I-93 Level of Service; South of Exit 4
8	Wednesday, October 18, 2000 West Running Brook School, Derry	General Conclusions Regarding Alternate Modes of Transportation
9	Wednesday, January 17, 2001 New Hampshire Department of Transportation, Concord	Presented ridership study results and conclusions and design concept plans prepared for Rationale Report
10	Wednesday, February 14, 2001 New Hampshire Department of Transportation, Concord	Discussed Rationale Report, Traffic LOS
11	Thursday, March 15, 2001 Windham	Field review of Castle Reach mitigation site
12	Wednesday, March 21, 2001 West Running Brook Middle School, Derry	Presented detailed design-MA line through Exit 2
13	Tuesday, April 10, 2001 Windham	Field review of Castle Reach mitigation site
14	Wednesday, April 18, 2001 West Running Brook Middle School, Derry	Presented detailed design-Segment 2 of Phase III design (Exit 3 area)
15	Wednesday, May 16, 2001 West Running Brook Middle School, Derry	Presented detailed design-Segment 3 of Phase III design (Exit 4 area)
16	Wednesday, June 20, 2001 West Running Brook Middle School, Derry	Presented detailed design-Segment 4 of Phase III design (Exit 5 area)
17	Wednesday, August 15, 2001 West Running Brook Middle School, Derry	Discussed Exits 1, 2, & 4
18	Thursday, September 19, 2001 West Running Brook Middle School, Derry	Exit 3 and 5 overview
19	Wednesday, October 17, 2001 West Running Brook Middle School, Derry	Discussed corridor resource impacts
20	Wednesday, November 21, 2001 NHDOT Design Conference Room	Discussed environmental matrix, wetlands quality, preferred alternative
21	Tuesday, January 8, 2002 I-93 Corridor	Field review of mitigation sites in Londonderry and Manchester
22	Wednesday, January 16, 2002 NHDOT Design Conference Room	Reported on the status of the wetland mitigation search process

Meeting No.	Date/Location	Topics
23	Monday, January 28, 2002 I-93 Corridor	Field review of mitigation sites in Salem, Windham and Derry
24	Wednesday, February 20, 2002 Londonderry, I-93 Corridor	Field review advanced mitigation sites (L8, L8 Ext., and L12) in Londonderry
25	Wednesday, February 20, 2002 Fisk School, Salem	Meeting with public to discuss wetland mitigation proposals
26	Thursday, July 18, 2002 I-93 Corridor	Field review of wetlands
27	Tuesday, December 3, 2002, VHB Bedford, NH Office	New England cottontail issue with USFWS and UNH
28	Thursday, December 5, 2002, NHDOT Bldg., Concord	Highway salt issues with EPA, plan 2002/3 collaborative winter sampling
29	Thursday, January 9, 2003, NHDOT Bldg., Concord	Cultural Resource Agency Meeting re: Prowse Bridge Determination
30	Tuesday, April 29, 2003, NHDOT Bldg.	Technical Assistance Program Organizational Meeting with NHOSP, NHDES, RPC's
31	Wednesday, May 21, 2003, NHDOT Bldg.	Technical Assistance Program Organizational Meeting with NHOSP, NHDES, RPC's
32	Wednesday, June 18, 2003, NHDOT Bldg.	Highway salt issue with USEPA, USGS, and NHDES
33	Wednesday, June 18, 2003, NHDOT Bldg., Concord	Technical Assistance Program outline with Resource Agencies including ACOE, NHDES, NHF&G, USFWS
34	Friday, June 20, 2003, NHDOT Bldg., Concord	Joint State Agency Memo
35	Thursday, June 26, 2003, NHDOT Bldg., Concord	Technical Assistance Program concepts with conservation work group (includes NHDES, USEPA, NHDF&G, SPNHF, NH Audubon, NH Lakes Assoc., NH Charitable Foundation, NH Sierra Club, UNH Cooperative Extension, CLF, Jordon Institute, NH Public Interest Research Group
37	Thursday July 31, 2003, EPA Lab, Chelmsford, MA	Highway salt issue with EPA, USACOE, USFWS, NHDF&G, and NHDES

Meeting No.	Date/Location	Topics
38	Wednesday, August 6, 2003, NHDF&G Department Building	Hognose snake issue with NHF&G Nongame Office
39	Wednesday August 6, 2003, Audubon Headquarters, Concord, NH	Highway salt issue with EPA, USFWS , NH Audubon and CLF
40	Thursday, August 14, 2003, NHDES Bldg, Concord	Technical Assistance Program concepts with conservation work group
41	Wednesday, September 3, 2003, NHDOT Bldg., Concord	Technical Assistance Program Organizational Meeting with NHOSP, NHDES, RPC's
42	Thursday, September 11, 2003, NHDOT Bldg., Concord	Cultural Resource Agency meeting re: Prowse Bridge avoidance alternatives
43	Tuesday, September 30, 2002, NHDOT Bldg., Concord	Highway salt, water quality issue with NHDES, USEPA
44	Wednesday, October 1, 2003, NHDOT Bldg., Concord	Prowse Bridge Mitigation with DHR
45	Friday, October 3, 2003, NHDOT Bldg., Concord	Meet with NHDES I-93 project team, coordination on issues
46	Thursday, October 9, 2003, NHDOT Bldg, Concord	Water Quality awareness education, coordination with NPDES II with NHDES, USEPA
47	Wednesday, October 15, 2003, NHDOT Bldg., Concord	Discuss project mitigation with Natural Resource Agencies including ACOE, NHDES, NHF&G, USFWS
48	Thursday, October 16, 2003, NHDOT Bldg., Concord	Technical Assistance Program Organizational Meeting with NHOSP, NHDES, RPC's; Technical Assistance Program organization and public outreach
49	Wednesday, November 12, 2003, NHDOT Bldg., Concord	Highway salt/water quality, planning collaborative 2003/4 winter sampling
50	Tuesday, November 18, 2003, NHDES Bldg., Concord	Technical Assistance Program organizational structure with conservation workgroup
51	Wednesday, December 17, 2003, NHDOT Bldg. Concord	Discussion of project mitigation and LEDPA with Natural Resource Agencies

8.3 Local Public Officials and Public Informational Meetings

As part of the Public Participation Program, informational meetings were regularly held with officials and the general public in the five communities affected by the project. Several meetings with second tier communities were held subsequent to the Public Hearings. The dates, location, and topics were as follows:

Meeting No.	Date/Location	Topics
1	Thursday, March 9, 2000 Town Offices, Londonderry	Public Officials Meeting: Project Purpose, Issues, Range of Alternatives, Schedule
2	Tuesday, March 13, 2000 Town Offices, Windham	Public Officials Meeting: Project Purpose, Issues, Range of Alternatives, Schedule
3	Thursday, March 16, 2000 Gerrity Community Center, Derry	Public Officials Meeting: Project Purpose, Issues, Range of Alternatives, Schedule
4	Wednesday, March 29, 2000 McLaughlin Middle School, Manchester	Public Officials Meeting: Project Purpose, Issues, Range of Alternatives, Schedule
5	Thursday, March 30, 2000 Town Offices, Salem	Public Officials Meeting: Project Purpose, Issues, Range of Alternatives, Schedule
6	Tuesday, November 28, 2000 McLaughlin Middle School, Manchester	Public Officials Meeting: Project Status, Ridership Study Conclusions, Alternatives to be carried forward, Schedule
7	Wednesday, November 29, 2000 Londonderry High School, Londonderry	Public Officials Meeting: Project Status, Ridership Study Conclusions, Alternatives to be carried forward, Schedule
8	Thursday, November 30, 2000 Windham Middle School, Windham	Public Officials Meeting: Project Status, Ridership Study Conclusions, Alternatives to be carried forward, Schedule
9	Thursday, December 7, 2000 West Running Brook Middle School, Derry	Public Informational Meeting: Presented ridership study results and conclusions and design concept plans prepared for Rationale Report.

Meeting No.	Date/Location	Topics
10	Wednesday, December 13, 2000 Fisk School, Salem	Public Informational Meeting: Presented ridership study results and conclusions and design concept plans prepared for Rational Report.
11	Monday, July 30, 2001 Salem High School, Salem	Public Informational Meeting: Salem-Exit 1 and 2
12	Tuesday, August 7, 2001 Windham Town Hall, Windham	Public Informational Meeting: Exit 3 revised concepts
13	Thursday, August 16, 2001 West Running Brook Middle School, Derry	Public Informational Meeting: Discuss area from Windham/Derry Town line through Exit 4 to Stonehenge Rd.
14	Tuesday, August 28, 2001 Windham Town Hall, Windham	Public Informational Meeting: Discuss area from Salem/Windham Town line to Windham/Derry Town line
15	Thursday, August 30, 2001 Londonderry High School	Public Informational Meeting: Discuss area from Derry/Londonderry Town line to Londonderry/Manchester Town line
16	Thursday, September 6, 2001 McLaughlin Middle School, Manchester	Public Informational Meeting: Discuss area from Exit 5 to Londonderry/Manchester Town line
17	Thursday, November 15, 2001 Salem High School Cafeteria	Public Informational Meeting: Identified the Department's preferred alternative through Salem
18	Monday, November 19, 2001 West Running Brook Middle School, Derry	Public Informational Meeting: Identified the Department's preferred alternative through Derry
19	Tuesday, November 20, 2001 Windham Middle School	Public Informational Meeting: Identified the Department's preferred alternative through Windham
20	Tuesday, November 27, 2001 Londonderry High School Cafeteria	Public Informational Meeting: Identified the Department's preferred alternative through Londonderry
21	Wednesday, November 28, 2001 McLaughlin Middle School, Manchester	Public Informational Meeting: Identified the Department's preferred alternative through Manchester
22	Tuesday, June 25, 2002 McLaughlin Middle School, Manchester	Public Informational Meeting: Overview of Preferred Alternative through Manchester

Meeting No.	Date/Location	Topics
23	Thursday, June 27, 2002 Salem High School	Public Informational Meeting: Overview of Preferred Alternative through Salem
24	Monday July 1, 2002 Windham Center School	Public Informational Meeting: Overview of Preferred Alternative through Windham
25	Tuesday, July 9, 2002 Londonderry Middle School	Public Informational Meeting: Overview of Preferred Alternative through Londonderry
26	Wednesday, July 10, 2002 West Running Brook Middle School, Derry	Public Informational Meeting: Overview of Preferred Alternative through Derry
27	Wednesday, September 25, 2002 Town Offices, Windham	Windham Planning Board, Conservation Committee Meeting: design issues/planning at Exit 3
28	Tuesday, October 22, 2002 Chester Multi Purpose Room	Public Information Meeting: Secondary Impact
29	Wednesday, October 23, 2002, Town Office, Salem	Salem Conservation Commission Meeting: Mitigation
30	Monday, November 4, 2002 Concord Rundlett Middle School	Public Information Meeting: Secondary Impacts
31	Thursday, November 21, 2002 Auburn Village School Cafeteria	Public Information Meeting: Secondary Impacts
32	Tuesday, November 26, 2002 Milford Town Hall Auditorium	Public Information Meeting: Secondary Impacts
33	Tuesday, November 26, 2002, Town Offices, Windham	Windham Officials Meeting: Mitigation
34	Wednesday, December 11, 2002 Goffstown High School Auditorium	Public Information Meeting: Secondary Impacts
35	Thursday, January 30, 2003 Candia Town Offices	Public Information Meeting: Secondary Impacts
36	Monday, May 5, 2003, Town Hall, Windham	Windham Selectmen's Meeting; Exit 3 design configuration
37	Monday, May 12, 2003, Town Offices, Salem	Salem Selectmen's Meeting: Water Quality issues at Canobie Lake

Meeting No.	Date/Location	Topics
38	Monday, May 19, 2003, Town Offices, Londonderry	Londonderry Town Council Meeting: Mitigation
39	Tuesday, June 18, 2003, McLaughlin Middle School, Manchester	Regional Smart Growth Meeting; Technical Assistance Program
40	Thursday, June 26, 2003, Community Resource Room, Concord	Regional Smart Growth Meeting; Technical Assistance Program
41	Friday, August 8, 2003, NHDOT Offices, Concord	Windham Conservation Commission, Town Manager; Mitigation
42	Wednesday, September 24, 2003, Town Offices , Londonderry	Londonderry Conservation Commission meeting: Mitigation
43	Thursday, October 23, 2003, Town Offices, Windham	Windham Conservation Commission Meeting; Mitigation

8.4 Public Hearing

After circulation of the DEIS, a formal Public Hearing was held over two evenings on November 12 and November 14, 2003, at the Salem High School and at the McLaughlin Middle School in Manchester, respectively. The Public Hearing was held jointly with the USACOE and NHDES. Comments on the preferred project alternative, DEIS and related issues were received at the Hearing. A summary of the Hearing comments are contained in Volume 3 of the FEIS and in more detail in the Commissioner's Report included in Appendix I.

8.5 Comments on the DEIS

Written comments on the DEIS were received for a 90-day period following distribution of the document. These comments were received from Federal and State agencies, local officials, regional planning agencies and organizations, private organizations and citizens. All of these comments and the official response to each of them are provided in a separate Volume 3 of this FEIS.

9

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10.2 Acronyms

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ASNH	Audubon Society of New Hampshire
ATF	Advisory Task Force
BMPs	Best Management Practices
CERCLA	Comprehensive Environmental Response, Compensation, Liability Act
CMAQ	Congestion Mitigation and Air Quality
CO	Carbon Monoxide
dBA	A-weighted decibels (noise levels)
DEIS	Draft Environmental Impact Statement
DOE	Determination of Eligibility
DOI	Department of Interior
DRED	New Hampshire Department of Resources and Economic Development
EM	Electromagnetic Geophysical Survey
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	US Department of Transportation, Federal Highway Administration
FPPA	Farmland Protection Policy Act
GPS	Global Positioning System
GTI	Guilford Transportation Industries
HABS	Historical American Buildings Survey
HAER	Historic American Engineering Record
HOV	High Occupancy Vehicles
HUD	Housing and Urban Development
I/M	Inspection and Maintenance
ISA	Initial Site Assessment
LEDPA	Least Environmentally Damaging Practicable Alternative
LOS	Level-of-Service

M&L	Manchester & Lawrence Branch
MA-DEM	Massachusetts Department of Environmental Management
MBTA	Massachusetts Bay Transportation Authority
MEMA	Massachusetts Emergency Management Agency
MEOTC	Massachusetts Executive Office of Transportation and Construction
MPO	Metropolitan Planning Organization
MS4	Municipal Separate Storm Sewer System
NAAQS	National Ambient Air Quality Standards
NEPA	Natural Environmental Policy Act
NHARD	New Hampshire Air Resources Division
NHDES	New Hampshire Department of Environmental Services
NHDHR	New Hampshire Division of Historical Resources
NHDOT	New Hampshire Department of Transportation
NHF&GD	New Hampshire Fish and Game Department
NHML	New Hampshire Mainline
NHNHI[46]	New Hampshire Natural Heritage Inventory
NHOSP[47]	New Hampshire Office of State Planning
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NOx	Nitric Oxide and Nitrogen Dioxide
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NWI	National Wetlands Inventory
OHM	Oil and/or Hazardous Materials
PSI	Preliminary Site Investigation
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
ROW	Right-of-Way
RSA	Revised Statues Annotated

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46 Since publication of the DEIS, the official name of this agency has been changed to the New Hampshire Natural Heritage Bureau (NHNHB).

47 The official name of this agency has been changed to the New Hampshire Office of Energy and Planning (NHOEP).

RWIS	Road Weather Information System
SCS	Soil Conservation Service (currently NRCS)
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SNHPC	Southern New Hampshire Planning Commission
SOV	Single Occupancy Vehicle
STIP	Statewide Transportation Improvement Program
TDM	Transportation Demand Management
TIP	Transportation Improvement Program
TMA	Transportation Management Association
TMO	Transportation Management Organization
TSM	Transportation Systems Management
USACOE	US Army Corps of Engineers
USDA	US Department of Agriculture
USDOT	United States Department of Transportation
USEPA	US Environmental Protection Agency
USFS	US Forest Service
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
WHPA	Wellhead Protection Area

11

Project Commitments

The following commitments have been made by NHDOT and FHWA to address or mitigate possible impacts associated with the Selected Alternative. See Section 4.0 for additional discussion and details.

A. Transportation

1. NHDOT will continue to coordinate the reconfiguration of the Exit 3 interchange with the Town of Windham to accommodate the Town's planning goals for the interchange area.

2. Three new park-and-ride lots will be constructed at Exit 2, 3 and 5, in addition to the overall corridor highway improvements to support carpooling and enhance ride-sharing opportunities.

3. New park-and-ride facilities will include the construction of terminal facilities to support expanded and enhanced bus service in the corridor. A terminal facility will also be considered at the existing park-and-ride lot at Exit 4 to promote consistent service with the corridor.

4. The park-and-ride facilities at Exit 2 and Exit 5 will be constructed in advance of the mainline highway widening work to provide options for commuters seeking alternatives during construction.

5. NHDOT will continue to work with regional and local officials to implement the recommendations of the Salem to Concord Bikeway Feasibility Study in lieu of in-corridor bicycle facilities. Paved shoulders along intersecting side roads are proposed for shared use bicycle lanes. Providing suitable accessibility for bicycle users through interchange areas will be considered in more detail during final design.

6. The current bus service to Boston that operates in the corridor will be expanded to provide service from the new park-and-ride bus station facilities along with the existing Exit 4 lot. NHDOT is committed to supplementing transit service as

an integral component of the Transportation System in the I-93 corridor as part of the funding strategy being developed.

7. All appropriate avenues of funding for bus service will be pursued including CMAQ and FTA funds. Full funding of bus purchases is anticipated along with construction of other required capital improvements (terminal and bus maintenance facilities). Assistance with operating costs for a 3-year start-up period is proposed with the intention that the service will achieve financial viability and be self-sufficient beyond this start-up period. As part of the overall funding strategy, funds for a transit marketing program are included.

8. NHDOT will continue to work towards providing enhanced ride-sharing opportunities. NHDOT will continue working cooperatively with public transit agencies, the MPO's, the TMO's and TMA's, as well as the Commonwealth of Massachusetts, to develop a coordinated transit program for the I-93 corridor. NHDOT will work with CARAVAN for Commuters to develop concepts for a ride-sharing program from southern New Hampshire that serves the entire I-93 corridor. NHDOT further proposes to subsidize a commuter incentive program in its early stages.

9. NHDOT will continue to develop and improve on Incident Management procedures in the corridor relative to response time, minimizing traffic delays and addressing traffic diversion issues. A number of Incident Management practices will be considered and implemented in the near-term, during construction, and over the long-term, following construction.

10. Intelligent Transportation System (ITS) technologies will be incorporated into the overall I-93 improvements to better manage traffic/travel demand, enhance safety and capacity, and supplement Incident Management initiatives. ITS deployment will be involved before, during, and after corridor construction.

11. The proposed layout will not preclude future mass transit opportunities within the I-93 corridor or along the former Manchester-Lawrence line. The Selected Alternative will accommodate room in the median to allow future mass transit opportunities in the corridor. In addition, the proposed layout will provide provisions, such as bridge replacements and continued grade-separated crossings at Exit 5, to facilitate possible future rail service on the Manchester-Lawrence line.

12. A Transit Investment Study will be jointly undertaken with the Commonwealth of Massachusetts to consider in more detail the long term rail and transit needs and identify viable options for the overall I-93 corridor between Manchester and Boston.

B. Air Quality

1. Air quality will continue to be addressed for the project through the regional Transportation Conformity Air Quality Analysis of the Statewide Transportation Improvement Program (STIP), which includes this project, in compliance with the State Implementation Plan (SIP). The project is, and will continue to be, included in a conforming STIP.

2. Mitigation measures for controlling fugitive dust emissions during construction will include wetting and stabilization of all work areas, cleaning paved roadways, and scheduling construction to minimize the amount and duration of exposed earth.

3. NHDOT will require that contractors involved with the reconstruction of I-93 include air pollution control devices on heavy diesel construction equipment in accordance with applicable State and Federal laws at the time of construction. The merits and practicality of more stringent or voluntary specification measures will be considered during the final design process and in consultation with the contracting community at large.

C. Surface Water Resources

1. Approximately 50 different extended-detention basins and 24 grass swales will be incorporated into the project design. The design objective will be to treat runoff from the entire length of new and reconstructed roadway, including the park-and-ride facilities and the secondary roads and ramps associated with the interchange areas. Both the basins and swales will be designed to maximize treatment efficiencies. Typical grass drainage swales will also be utilized in the project to collect and convey storm water runoff and will provide supplemental treatment benefits.

2. I-93 will be relocated toward the median in the vicinity of the Exit 3 Interchange to reduce the overall footprint of the interchange and provide additional buffer area between the highway and Canobie Lake and Cobbetts Pond to enhance water quality protections and opportunities.

3. The drainage design, treatment swales, and detention basins will include specific spill containment measures in the vicinity of Canobie Lake to capture and isolate any inadvertent hazardous material spills before they can reach Canobie Lake.

4. NHDOT will specify in the contract bid documents that only low phosphorus or no phosphorus fertilizers are to be used in the re-establishment of vegetation within the watershed areas of Canobie Lake and Cobbetts Pond to minimize the potential phosphorus contributions associated with the use of fertilizers during project construction.

5. Opportunities to divert runoff into the watershed of Canobie Lake will be further explored in final design, as requested by the Salem Board of Selectmen, in order to maximize the surface recharge to the Lake.

6. NHDOT will coordinate with regulated MS4 communities as part of its obligations in meeting the small MS4 regulations under the NPDES Phase II Program in addressing storm water management and treatment measures, eliminating any illicit discharges within the storm drain systems, implementing spill prevention and containment measures with emergency response personnel, and general good housekeeping measures. NHDOT will prepare annual reports detailing the activities and efforts that were undertaken as part of the five-year Statewide Storm Water Management Plan under the NPDES Phase II Permit Program, and how the measurable goals were met.

7. NHDOT will continue to pursue best management practices for road salt to optimize the use of material to maximize efficiency and effectiveness of de-icer application. The project will incorporate a Road Weather Information System (RWIS) to provide maintenance staff, real time pavement temperature and moisture data that supports more effective decision making. NHDOT will utilize the Maintenance Decision Support System (MDSS), an advanced decision support tool for winter maintenance managers currently under development, to maximize the efficiency of winter maintenance operations to reduce salt usage with precision timing of material application.

8. NHDOT will standardize the use of "pre-wetting" road salt and ground oriented spreader application of road salt to limit scatter and increase effectiveness of applied de-icing material.

9. NHDOT will replace and refurbish its vehicle fleet and equipment used to maintain I-93 over approximately the next 10 years and will include equipment to increase efficiency of operations. Equipment purchases will include items such as infrared thermometers to adjust de-icer applications based on specific pavement temperature, and under body scraper plows which remove snow more effectively requiring less de-icer.

10. NHDOT will institute the use of salt brine, a mixture of road salt and water spray applied to roadway surface, to reduce and mitigate the amount of road salt applied to this section of I-93.

11. Frequent and systematic training of maintenance personnel will be conducted for the crews maintaining I-93 on salt management reduction techniques and the environmentally sensitive areas along the corridor. Trained NHDOT personnel and equipment will be prioritized for the I-93 corridor winter maintenance over private contractors and equipment.

12. Sensitive environmental areas will be identified and marked for field crews maintaining I-93 and to raise awareness of the motoring public.

13. NHDOT will continue to explore the effectiveness and practicability of alternative de-icers, through limited pilot studies and experiments throughout the State, for potential use in environmentally sensitive areas.

14. During the construction phase, additional measures will be undertaken as practicable to ensure that the water quality of Canobie Lake, Cobbetts Pond, and other brooks, streams and wetlands are protected. NHDOT will ensure that Storm Water Pollution Prevention Plans (SWPPP) are prepared for each construction contract per NHDES requirements and the USEPA NPDES Phase II requirements and guidelines for construction activities. The goal of the SWPPP(s) is to reduce or eliminate stormwater pollution from construction activity by implementing pollution control Best Management Practices (BMP's) to protect water quality, including designing and implementing erosion and sediment control measures appropriate for the project specific construction activities and resources. Prior to the commencement of work, the Contractor will submit an erosion control and stormwater management plan specific to the project that will present measures to be employed to limit the extent and duration of exposed soils, temporary stabilization measures to be used and containment measures to prevent downstream sedimentation and turbidity.

15. All requirements of the Construction General Permit (CGP) will be met for each construction contract including a Notice of Intent, implementation of the SWPPP, and Notice of Termination upon completion.

16. NHDOT will continue to participate with NHDES and USEPA with respect to the regional issues of elevated chloride levels in area streams. NHDOT will participate in continuing water quality monitoring efforts as they relate to characteristics of I-93's contributions and coordinate with NHDES relative to its VLAP Program for monitoring any future changes in chloride concentrations associated with Dinsmore Brook, Cobbetts Pond, and the tributaries to Canobie Lake. NHDOT will participate in the anticipated regional TMDL study and work towards implementing appropriate road salt management plans that may be developed.

17. NHDOT will also coordinate and exchange information with local DPW officials regarding new and more efficient ways to store and apply road salt for deicing purposes through the outreach and education efforts as part of the Phase II

Storm Water Management Plan, discussed above. NHDOT will share its technical experiences and knowledge, provide technical assistance to communities, and investigate venues and opportunities, such as through the UNH Technology Transfer Center, for sharing knowledge and experience relative to road salt management and application techniques.

18. NHDOT will provide funding of up to $3 million to the NHDES Drinking Water Supply Land Grant Program to be used to purchase property rights to aid in the protection of water quality around Massabesic Lake, which is used to supply drinking water to Manchester, and parts of Derry and Londonderry.

D. Groundwater Resources

1. The Selected Alternative will incorporate extended-detention basins and grassed swales to treat roadway runoff for nearly the entire new and reconstructed roadway, including existing pavement areas. This is consistent with NHDES's *Recommendations for Groundwater Protection Measures When Siting or Improving Roadways*, and Level 2 protection measures for all new and improved roadways in Wellhead Protection Areas (WHPAs), locally designated groundwater protection areas or areas classified as GA1 areas (i.e., watersheds or recharge areas to existing or future water supplies) under the WHPA Program.

2. Consistent with the NHDES (1995) recommendations, the practicability of Level 3 measures including impermeable drainage swales and detention basins, and diversion runoff will be evaluated during final design for portions of the reconstructed roadway within 1,000 feet of a community well or 500 feet of the non-community, non-transient wells. This includes specifically the Boumil Grove Condominium's well in Londonderry which is within 500 feet of the proposed roadway area. In lieu of these measures, the possibility of connecting this condominium complex to the nearby municipal water system may also be explored.

3. With the "tight-shift" design option, the I-93 roadway in the vicinity of the Pennichuck wells will be relocated further away as part of the Selected Alternative, and will require only Level 2 protection measures.

4. The same mitigation measures relative to road salt that were described for Surface Water Resources will also protect groundwater resources.

5. As part of the final design, NHDOT will also identify and specify precautions to minimize potential blasting impacts during construction for all known public and private wells within 1000 feet of a blasting area. NHDOT will also coordinate with the area utilities just prior to construction to prevent and repair any inadvertent damage to underground distribution lines.

6. NHDOT will investigate and replace any wells that are subsequently found to be damaged or degraded as a result of NHDOT activities through its Well Replacement Program. In accordance with RSA 228: 34, NHDOT will conduct remedial measures for any wells that are found to have been impacted by construction or maintenance activities in relation to a state highway.

E. Floodplains

1. Direct impacts to the 100-year floodplain and floodways will be minimized during final design, by steepening highway embankments and/or utilizing retaining walls where appropriate. Such locations include the areas adjacent to the Spicket River, Policy Brook, and Porcupine Brook in Salem; Beaver Brook in Derry and Londonderry, Wheeler Pond in Londonderry, and Cohas Brook in Manchester.

2. A series of up to 14 basins will be constructed at locations immediately adjacent to impacted floodplains or where natural valley storage is being lost.

3. Additional flood storage compensation will be created at locations adjacent to flood-susceptible brooks and rivers, or locations upgradient from flood-prone areas. Detention basins are being proposed for stormwater treatment and floodwater storage at a number of locations along the widened highway. These basins are typically designed to store up to a 50-year storm event before discharging to nearby watercourses.

4. The design of the wetland creation sites will include the goal of providing both floodflow alternation and compensatory flood storage. These sites include the Pelham Road Mitigation Site, Waste Water Treatment Plant Site, and Baggett Site in Salem; Highway Median Site in Windham; and South Road Mitigation Site in Londonderry.

F. Farmlands

1. For impacts that cannot be avoided, owners will be compensated through the right-of-way and acquisition process.

2. Top soil will be salvaged during construction and will be re-used on roadway side slopes for revegetation and stabilization.

G. Wetlands

1. Compensation for unavoidable losses of wetlands and other project impacts will include a combination of creation, restoration/enhancement, and preservation of the following project mitigation/enhancement package, involving protection of approximately 1,000 acres at 16 sites throughout the study corridor. The recommended mitigation sites are summarized as follows:

Salem

Total mitigation provided by four sites will amount to 90 acres (including creation, preservation, and flood storage replacement elements). These sites are:

- Cluff Crossing Road (Site #30), 27 acre parcel
- Pelham Road Mitigation Site (Site #31), 25-acre parcel
- Salem Wastewater Treatment Plant Site (Site #32), 32-acre site
- Baggett Property (Site #38) about 6 acres in size,

Windham

Total mitigation provided by three sites in Windham will amount to nearly 318 acres (creation, preservation, and flood storage replacement). Each of the sites is described below.

- Highway Median Site (Site #24), 17-acre parcel
- Armstrong Property (Site #49), 11-acre parcel
- Southeast Lands Area (Site # 45), approximately 290 acres

Derry

Total mitigation provided by the site in Derry would amount to nearly 200 acres (preservation). The proposed mitigation site is described below.

- Sybiak Farm Property (Site #16)

Londonderry

Total mitigation provided by three sites will amount to nearly 290 acres (approximately 299 acres of preservation within which 10 to 12 acres of wetland would be created at the South Road site). The site has also been identified a potential location for passive recreational use by townspeople.

- South Road Mitigation Site (Site #14 and 15), 75-acre parcel
- Norwood Site (Site #63), 37-acre parcel
- Musquash Brook Parcels (Site #61), 110 acres
- Scobie Pond Area Properties (Site #58), 70 acres

Manchester

Total mitigation provided by the Crystal Lake sites in Manchester will amount to about 120 acres (preservation). The sites are described below.

- Crystal Lake Area Properties (Site #3, 44, 46, 47, and 53).

2. As noted previously, $3 million in funding will be provided to the NHDES Drinking Water Supply Land Grant Program to protect the watershed surrounding Massabesic Lake. This land and water quality protection effort, in combination with the commitment to provide funding to communities for

planning technical assistance, will provide future protection of wetland, as well as upland, resources in the I-93 region.

3. Attempts will be made to further minimize wetland impacts during final design by steepening slope embankments, where appropriate.

H. Wildlife and Fisheries Resources

1. Direct habitat loss, in particular to wetlands, will be offset through the project mitigation in the form of extensive habitat preservation. Generally the preservation sites will be contiguous with adjacent undeveloped or protected properties to create larger unfragmented blocks and provide opportunity to manage portions for varying successional stages.

2. The design of the wetland creation sites will include the goal of replacing the wildlife functions of impacted wetlands. Construction plans for restoration, enhancement, and creation will attempt to maximize the diversity and interspersion of wildlife food and cover, as done at the advanced wetland mitigation sites in Salem (Pelham Road) and Londonderry (South Road). A diverse group of native wetland plant species will be planted where appropriate to create a high structural and plant species diversity attractive to a wide variety of wildlife.

3. All culverts and bridges at the major stream crossings along the highway corridor (i.e., Cohas Brook, Beaver Brook, Porcupine Brook and Policy Brook) will be examined during final design to determine how a dry-land passage ("shelf") for mammals can be incorporated into the structures.

4. Other culvert crossings for smaller perennial streams will also be examined to ensure there are no blockages to wildlife or fish passage. A number of potential improvements to culvert conditions to enhance passage of fish and wildlife have been identified and will be evaluated during final design and implemented where practical. For culverts that require replacement, consideration will be given to oversizing the new structures, as appropriate, to better facilitate wildlife crossing.

5. Data will also continue to be collected by District Maintenance staff on the frequency of wildlife–vehicle collisions so that this information can be used to decide whether additional warning signage or fencing along the highway is warranted.

6. Several measures will be taken during construction to further reduce impacts on wildlife habitat. The amount of land cleared of vegetation will be limited as practical, especially in areas where there are currently only narrow buffer strips between the highway and other human development. Re-vegetation of the land disturbed by construction activities will take place as soon as possible after

construction is completed, so that erosion is minimized and wildlife habitat is restored. Brush clearing or tree thinning in forests adjacent to the construction areas will not be proposed. Where feasible and safe, snags (i.e., dead standing trees) will be left adjacent to the mowed sections of the right-of-way in order to provide perch sites, nesting cavities, and den sites for wildlife.

7. Maintenance of the highway right-of-way to provide clear zone areas will be limited to the degree practical. On the one hand, maintaining large swaths of open areas are expensive and not beneficial to wildlife. On the other hand, providing clear zones for motorist's safety and discouraging wildlife from approaching the highway will be important.

I. Endangered and Threatened Species

1. Mitigation of impacts to wild lupine south of Exit 3 will focus on relocating these individuals by means of re-seeding or transplantation. A written mitigation plan specific to this population will be completed in consultation with the NHNHI prior to construction.

2. A preconstruction study conducted in conjunction with the NHF&GD of potential eastern hognose snake habitat using GIS-level analysis and/or other means will evaluate a sample of known occupied habitats within southern New Hampshire to determine their characteristics. This effort will help identify potential habitat within the project area that might be affected.

3. Construction contractor personnel will be trained to recognize the hognose snake and be informed of its protected status through a cooperative effort of NHDOT and NHF&GD. Procedures for reporting occurrences of the snake will be established to ensure proper response and reporting of the snake if encountered during construction.

J. Noise

1. Noise barriers will be constructed at 11 locations along the project corridor in accordance with noise analysis and applicable criteria. (See Table 4.8-2)

2. Early construction of proposed noise barriers will be considered in the construction sequencing, as appropriate, so that they can provide a reduction in subsequent construction noise to the residences.

K. Visual Resources

1. Landscape planting and natural revegetation of all cut and fill slopes and, at the park-and-ride facilities will be developed during final design, as appropriate.

2. Structural design considerations for drainage structures, bridges, etc., to enhance their visual appearance will be considered during final design.

3. Highway lighting at interchanges and park-and-ride facilities, where appropriate, will be designed with "cut offs" or similar features to limit unwanted light.

4. Sound walls will serve a dual purpose by mitigating for both noise and visual impacts. Landscaping amenities will also be added in conjunction with the construction of sound walls where practicable.

5. Privacy fencing will be constructed in four locations (at NH 111A in Windham, Fordway Extension in Derry, Charleston Avenue in Londonderry, and Rockingham Road in Londonderry) to help shield adjacent residential properties from the visual impacts of the highway.

6. Additional privacy fence locations or landscape screening to minimize the visual impact of the highway and mitigate for the loss of existing vegetative screening will be considered and evaluated as part of the discussions with affected property owners during final design.

L. Cultural Resources

1. A Memorandum of Agreement (MOA) has been executed between the FHWA and NHSHPO, with concurrence by NHDOT. The specific mitigation measures are detailed in the MOA (Appendix G).

2. Archaeological investigations at the Phase II level will be conducted to determine eligibility of sites identified for further evaluation. Depending on site significance and determination of effects, mitigation may be required including preservation-in-place or data recovery.

3. Mitigation for the direct impact to the George F. Armstrong House is to document the buildings to Historic American Building Survey (HABS) standards. It will be reconveyed to the property owner or marketed with protective covenant for relocation. A portion of the demolition costs may be allocated as an incentive for relocation.

4. Mitigation for the direct impact to the Robert Armstrong House is to, in part, document the building to HABS standards. The building will be purchased and, if feasible, it will be relocated to a nearby location with a suitable setting. A building relocation study will be conducted for the move. The property will be conveyed to a new owner with agreed to preservation/maintenance covenants.

5. Mitigation for removal of the Robert Prowse Memorial Bridge is, in part, to document the bridge to Historic American Engineering Records (HAER) standards. The bridge will be replaced by a steel rigid frame structure of compatible design, if feasible. A concerted effort will be made to find an

adaptive reuse for the bridge prior to construction. Otherwise, it will be advertised and marketed for reuse by others. An interpretative exhibit about its design and fabrication will be placed at the Salem Rest Area.

6. Mitigation for impacts to the Gearty House property is to minimize acquisition and slope impacts. Further reductions in slope impacts and acquisition will be considered during final design.

7. NHDOT will document the stone walls associated with Searles Castle that are impacted by the project.

8. If impacted, cultural resources included in the wetland mitigation and park-and-ride sites will be documented.

9. NHDOT shall ensure that all purchased historic properties are secured and protected against damage.

M. Socio-Economic Resources

1. Properties requiring acquisition will be appraised utilizing techniques recognized and accepted by the appraising profession and in conformity with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, and applicable to New Hampshire State Law to determine fair market value. The amount offered for partial acquisitions will be the difference between the fair market value of the property before the highway is built and its value after the portion needed for the highway has been acquired.

2. The following relocation benefits will be made available to displaced residences:

   - Fair market value for acquired property
   - Relocation advisory assistance services
   - Payments for moving and relocation costs
   - Replacement housing payments for home owners
   - Residential mortgage interest differential payments and closing costs
   - Replacement housing payments for tenants

3. The following relocation benefits will be made available to displaced businesses:

   - Fair market value for acquired property
   - Relocation advisory assistance services
   - Payments for actual reasonable moving
   - Business re-establishment costs

4. Should identifying affordable housing for any displaced residents (owners or renters) within the existing housing stock and assistance programs prove unfeasible, last resort housing will be made available, if necessary, in accordance

with Section 206 of the Uniform Act and governing regulations. As part of the right-of-way acquisition process, particular attention will be given to the current residents of these properties to assure that the needs of the displaced individuals are adequately addressed and the project will not knowingly discriminate against low-income and minority residents of the project area.

5. NHDOT will continue to coordinate through the design process with the communities to develop project improvements in keeping with their planning goals for potential redevelopment in impacted interchange areas.

N. Secondary Land Use Impacts

1. $3.5 million will be provided for the establishment of a Community Technical Assistance Program to help communities in the area influenced by this section of I-93 better deal with and manage growth related issues.

O. Hazardous Materials

1. Initial Site Assessment (ISAs), and Preliminary Site Investigations (PSIs) as necessary, of properties to be acquired will be performed to address potential and confirmed areas of soil or groundwater contamination.

2. Based on the results of the PSIs, contamination may be identified. In the event contamination is identified, the following scenarios are likely:

   - Contamination is limited to groundwater that does not warrant remediation and the groundwater will not be encountered during construction.

   - Contamination is limited to soil that does not warrant remediation and the contaminated soil will not be encountered during construction.

   - The contaminated soil or groundwater identified requires remediation by NHDOT following property acquisition.

   - The contaminated groundwater encountered will not be encountered during construction and assessment/remediation is ongoing by the existing property owner as part of an existing Groundwater Management Zone (GMZ) permit.

   - Limits of solid waste will be categorized. Removal, or consolidation of solid waste on-site will be performed in consultation with NHDES.

3. If contaminated materials are expected to be encountered during construction, appropriate worker health and safety provisions and waste management provisions will be included in the construction documents. All work will be performed in accordance with applicable NHDES regulations and NHDES-approved remedial action plans.

4. A comprehensive building audit will be performed prior to any scheduled demolition to identify and quantify all regulated building materials and special wastes. Abatement plans will be prepared to address the removal of all regulated building materials.

P. Construction

1. To mitigate potential sedimentation impacts during construction, a detailed drainage and erosion control program including BMPs will be developed implemented. Construction schedules will require that areas stripped of vegetation be limited in size and either surfaced or vegetated as quickly as possible after initial exposure. Temporary erosion check-dams will be installed during the construction period in appropriate locations.

2. The detailed guidance contained in *NHDOT's Standard Specifications for Road and Bridge Construction, Section 699, Temporary Project Water Pollution Control (Soil Erosion)* will be followed.

3. In general, construction will be accomplished during daylight hours to minimize noise impacts, although some night-time construction should be expected given the traffic volumes during daylight hours and the need to maintain traffic at these times.

4. A detailed Traffic Control Plan will be developed as part of the final design and instituted to reduce traffic-related short-term impacts and minimize delays. The plan will include the requirement to maintain 2-lanes of traffic in both directions along the mainline for normal construction activities, and during high volume traffic periods.

5. Intelligent Transportation Systems, such as Smart Workzone Technologies, will be employed to more efficiently manage traffic/travel demand and enhance incident management. Specific Incident Management procedures and protocols will be incorporated into the contract documents and specifications.

6. Construction activities will be coordinated with all property owners (both business and residential) to assure that reasonable access to properties is maintained. Temporary signing and other issues related to temporary relocation of access points caused by construction activities will be appropriately addressed on an individual basis.

7. Land that is disturbed by construction activities will be re-vegetated as soon as possible after construction is completed to minimize erosion and restore wildlife habitat.

8. Construction contractor personnel will be trained to recognize the hognose snake and be informed of its protected status through a cooperative effort of NHDOT and NHF&GD. Procedures for reporting occurrences of the snake will be established to ensure proper response and reporting of the snake if encountered during construction.

Salem to Manchester

VHB *Vanasse Hangen Brustlin, Inc.*